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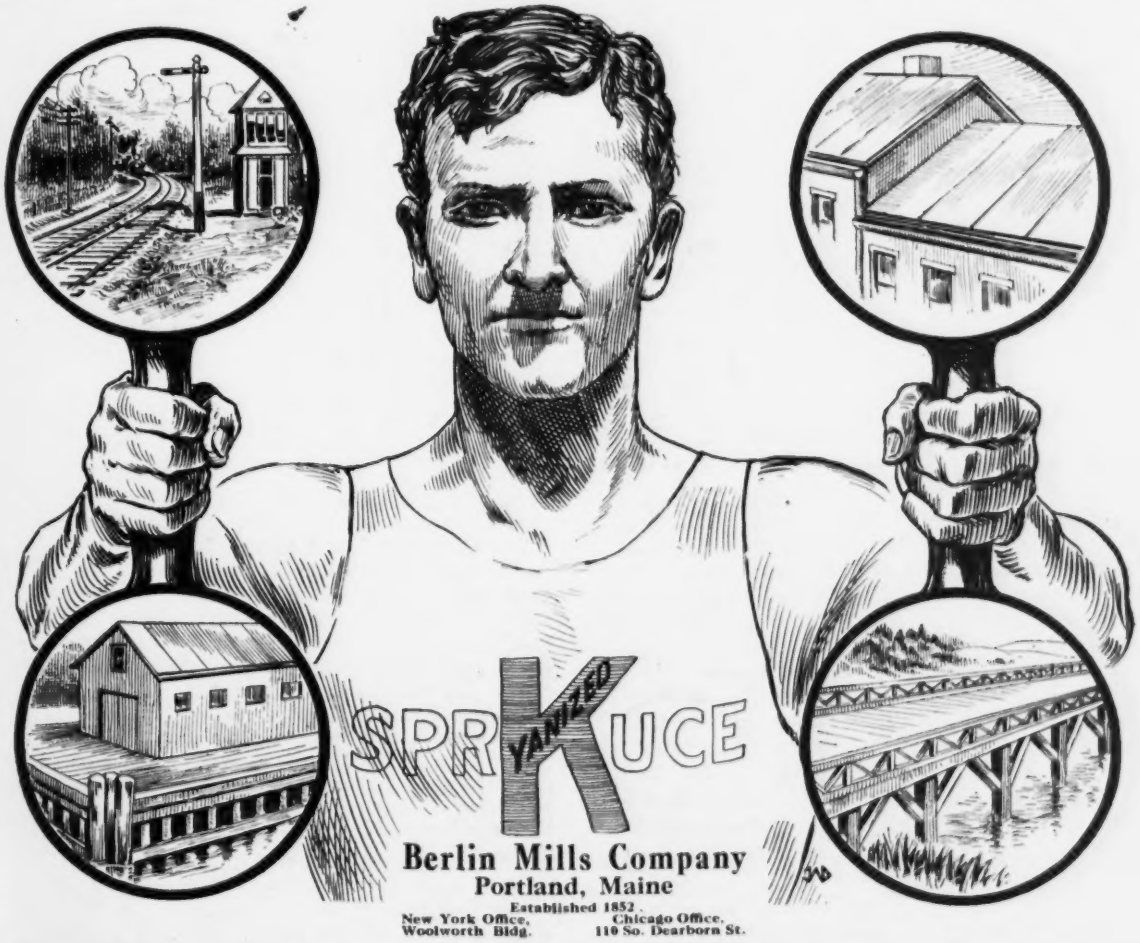
FOR STRENGTH AND ENDURANCE KYANIZED SPRUCE IS SUPREME



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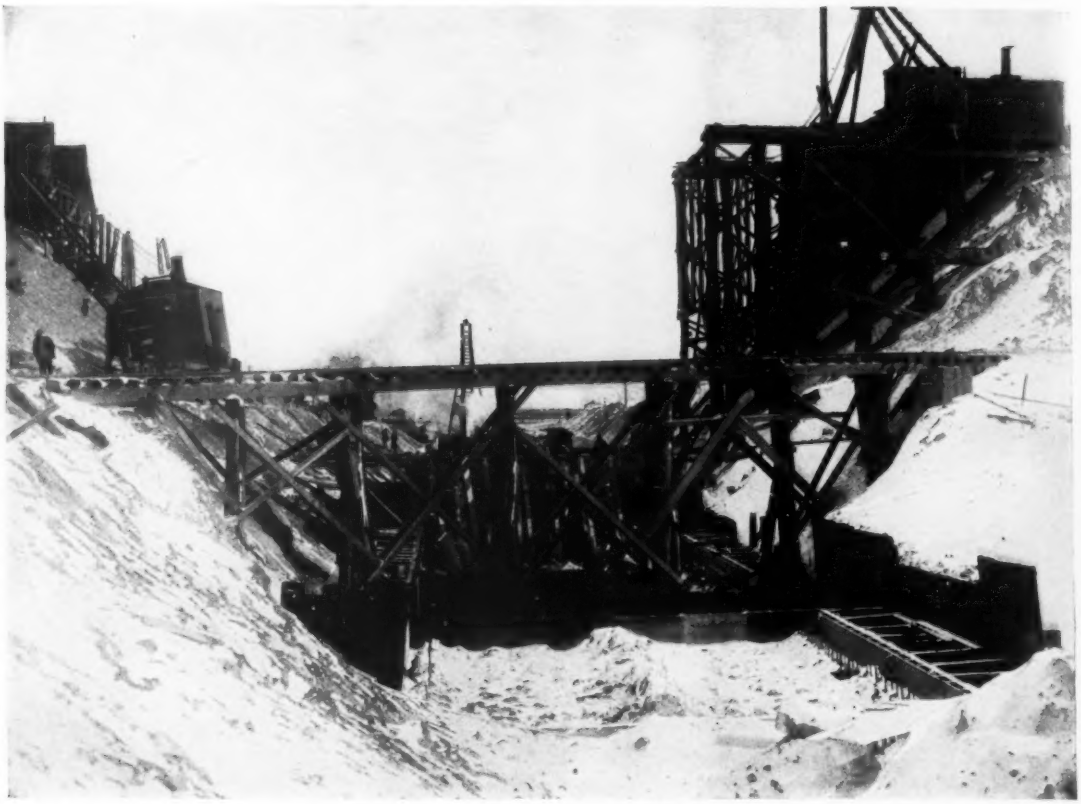

Lackawanna Steel Sheet Piling Used In Repairing The Irondequoit Break In The New York State Barge Canal

The large break in the New York State Barge Canal which occurred in Sept. 1912 at the crossing of the Irondequoit Creek culvert east of Rochester was temporarily repaired by partially refilling the washout with sand and building a timber flume supported by piles driven into the new fill. This temporary flume is now being permanently replaced by Myers & McWilliams, Contractors, under direction of the State Superintendent of Public Works, by excavating a trench across the old embankment down to water level, excavating a cofferdam below water level, building a new double-box reinforced-concrete culvert and replacing the embankment.

The new culvert is to be supported on wooden foundation piles the site of which is being kept open and free from seepage by walls of Lackawanna Steel Sheet Piling. Part of this cofferdam is shown in the picture above.

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Engineering News

VOLUME 75 MAY 11, 1916 NUMBER 19

Bridge Washouts in the Desert

To those engineers who think of Arizona as an arid region it may seem strange that the principal difficulties of highway engineers in this desert country are washouts. This was particularly brought home in the January floods of 1916, which carried away so many bridge structures in both southern California and southern Arizona. The occasional failures of these large structures in an unusual flood are generally widely heralded; but after all, such damage is but a fraction of the aggregate flood damage to scores of other structures, which are damaged or destroyed under similar conditions almost every year. There is probably no more perplexing and baffling problem before the highway engineers of the arid Southwest than that of how to build and how to protect their structures against the eccentricities of rivers like the Colorado and its numerous tributaries as the Gila, the Salt and many others. These streams carry enormous amounts of silt, and their beds are built up of this material from a great depth. In times of low water—some of these streams become practically dry at times—the river beds grow up with willows and cottonwood trees that catch the silt and for a time give security to the banks. When extra-high water comes, the trees are uprooted and form temporary barriers that deflect the current to one bank or the other. Then a scouring commences, the end of which no man can foresee.

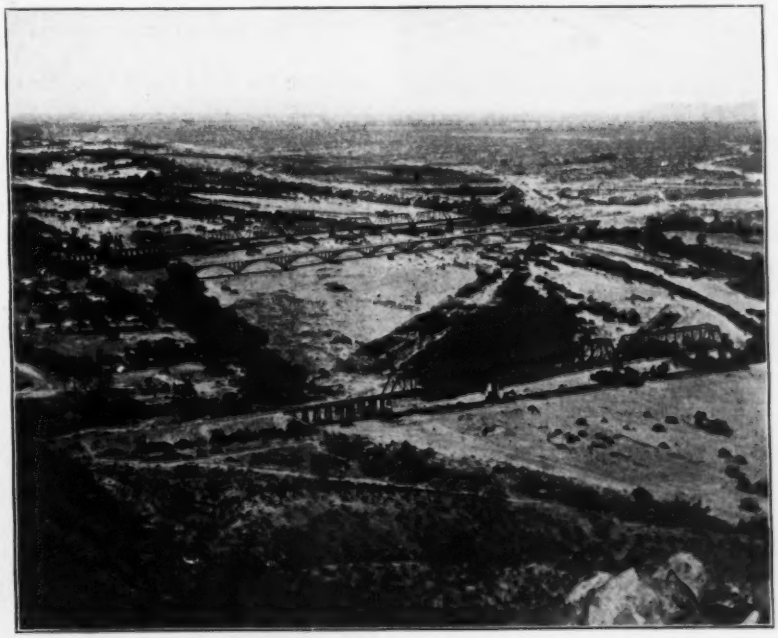


FIG. 1. VIEW OF SALT RIVER VALLEY NEAR TEMPE, ARIZ., SHOWING THREE BRIDGES

Typical conditions in these valleys are shown in Fig. 1, which gives a better idea than a topographic map. This is a view near Tempe, in the Salt River Valley, a few miles above Phoenix. In the foreground are three spans of the Santa Fe railway bridge, the remainder of which was washed out several years ago. Beyond is the concrete-arch state-highway bridge described in *Engineering News*, Mar. 28, 1912, p. 578, by James B. Girand, then Territorial Engineer. The third bridge is that of the Arizona Eastern R.R. The present course of the river can be seen at the extreme right.

Fig. 2 shows graphically what happens under flood conditions. It appears to be a view of a limitless lake; but if one looks closely, one can make out a bridge in the background. This is a 14-span reinforced-concrete girder bridge 700 ft. long, carrying a state highway across the Gila River, near Florence, Ariz. The bridge itself is undamaged, but the river has left its old channel and washed away 1,200 ft. of the approach embankment on the south end of the bridge. The waste of waters in the foreground of the view is flowing over this approach. It is of course impracticable and impossible with the funds available to extend the bridge across the new channel. Instead, it is proposed to compel the stream to return to its former channel. Work has already been begun by State Engineer Lamar Cobb to open up a diversion channel leading the river to its proper place underneath the bridge. To do this it will probably be necessary to build a temporary dam or dike across the stream at the entrance to the channel. The embankment will then be replaced and probably rip-rapped, if sufficient funds are available. At best this is but a temporary expedient, since there is no assurance that the river will not cut the same caper again.

A washout of almost identically the same character occurred in Pima County, where the county engineer, W. C. Goetz, is deflecting the current back under the bridge by means of jetties made of fencing fastened to 2-in. boiler tubes, 14 ft. long, driven 10 ft. into the ground. Two rows of this wire fencing are used, spaced 4 ft. apart, and the space between is filled with brush weighted with stone to form a mattress dike or crib.

This is the favorite method of protection where the stream is not too large and conditions permit. Fig. 3

shows work of a similar nature designed to prevent the erosion of the side of the Grand Canal in the Salt River Valley, at a place where it comes close to the river bank. The jetty here consists of a stepped earth embankment faced with a brush mattress made by filling a 12-in. space between a wire fence and the face of the embankment with willow brush. Willow sprouts are being planted along the toe of the embankment to afford a permanent protection to the fill. Walter Ward is the construction

FIG. 2. GILA RIVER NEAR FLORENCE, ARIZ., IN FLOOD
Note bridge in the background

engineer, Salt River project, United States Reclamation Service. W. S. Cone is Project Manager.

A bridge-approach washout similar to those described, but not so serious, occurred at the Central Ave. bridge, Phœnix, Ariz. Here the Salt River subsequently returned to its normal channel of its own accord.

When it is remembered that the silt of many of these streams extends to such a depth that it is impossible to found the piers on rock and that in flood times the streams carry enormous amounts of drift and silt, it is not to be wondered at that failures are frequent. It is very hard under the circumstances to guarantee success; for if the bridge be strong enough to resist, it only assists in diverting the flood around one end—and the loss of a fill of any considerable depth mounts into money pretty rapidly.

Engineering Society Service*

By Edmund M. Blake†

The building up of an engineering society depends upon the correlated service of every member. Application for membership and its acceptance should carry with it not only the willingness to give, but the intention of giving, service. We who are following the greatest profession in the world have adopted engineering as our life work only after careful thought, deep consideration of all the branches of life's activities and usually a long scientific or practical preparation. If we are not loyal to engineering as the profession we have ourselves chosen, we should abandon it at once. If we are loyal to it, then the upbuilding and strengthening of our chosen profession should be one of the primary motives of our work. We cannot draw from a bank unless we have put in something to draw upon, and the more we put in the more we can draw out. It is equally true of the engineering profession. We must invest in it all we have, constantly adding to that investment as the years go by, if we are to share in the full returns.

An engineering society represents a coöperative effort by the engineering profession to consolidate its members into a concrete and united organization for the upbuilding and strengthening of the profession, for the benefits of personal contact and professional interchange of engineering knowledge, ideas and advice, for the purpose of commanding a broader recognition and a higher valuation of the engineering profession by the public for the publication and dissemination of the best in engineering theory, design and practice and the compilation of data. The individual member should be instilled with a true spirit of service, with an ambition to contribute toward the accomplishment of these purposes more than his share and with a very clear realization that his application for membership in the society is not accepted primarily as adding one more wheel unit to the installation, but rather in the nature of additional second-feed of flow to be credited to plant capacity.

With this conception firmly established in his mind, the engineer who joins the society will consider of first importance the question of what he can add to the society and not of what he can get out of the society in return for his annual dues. Service for the society will follow, and soon there will be no need of arguing the other

FIG. 3. EARTH JETTY WITH BRUSH MATTRESSES, GRAND CANAL, SALT RIVER VALLEY

side—that of the benefits to be received from membership in the society. This conception will not foster any false valuation of present personal contribution to the society, but rather will create an ambition to make the net final contribution represent the maximum possible individual output, always remembering that the engineering society is the one great concrete medium of contribution to the engineering profession.

The Boston Society of Civil Engineers was founded in 1848 and is the oldest engineering society in the United States. Its membership comprises those interested in mechanical and electrical, as well as in civil, engineering, and its officers have included prominent members of all three branches of the profession. Today its total active membership has reached one thousand, composed of mem-

*From the "Journal" of the Boston Society of Civil Engineers for April, 1916.

†Civil Engineer, Brookline, Mass.

bers, junior and associate members and honorary members, and it has established a permanent and safely invested fund of over $37,000. It seems, to use an inadequate simile, like a big battleship ready for launching; but that does not mean necessarily a membership limited to one thousand with a waiting list, nor a permanent fund of only $37,000, nor in any way a reflection adversely upon the net result of past efforts, but rather the highest commendation for the achievements and distinction already won. The society is now 68 years old. Many of its present members may not answer the one-hundredth anniversary roll call in 1948. It can never hope to approximate the membership total of the American Society of Civil Engineers, but in quality, solidity and scientific achievement, in service to the engineering profession, fraternal *esprit de corps* and its contribution to the engineering literature of the world it is possible for the Boston Society of Civil Engineers to establish its claim as the foremost engineering society in the United States on or before its centennial anniversary in 1948.

Power Possibilities of Federal Irrigation Projects*

By A. P. Davis†

The United States Reclamation Service in the construction of irrigation works has on many of its projects a byproduct in the shape of hydro-electric power, usually in blocks too small to be considered in connection with any extensive electrochemical industry, but in a few cases large enough to be thus utilized. In addition thereto, investigation has been made of possible power development for the primary purpose of pumping water for irrigation.

On the Minidoka project in southern Idaho a diversion dam provides storage and a head of 46 ft. upon the wheels of a 10,000-hp. power plant. This capacity can be doubled at a reasonable cost. The power now developed is fully utilized only during the summer months. Undeveloped power sites along the Snake River in the same region could be made to produce several hundred thousand horsepower for eight or ten months in the year.

On the Boise project in Idaho the Reclamation Service has built a high masonry storage dam about 240 ft. above the river bed. More than 1,000,000 acre-ft. of water have to pass this dam site every year. Power development here could utilize the 60- to 230-ft. head in the reservoir. The quantity of water available during the summer would be about 5,000 sec.-ft., but in the winter only about 200 sec.-ft. Provision has been made for the convenient installation of 17,000 hp. in generating units.

The Pathfinder dam on the North Platte River, Wyoming, is 210 ft. high, forms a reservoir of 1,100,000 acre-ft. and intercepts an annual flow that varies from 1,000,000 acre-ft. to over 3,000,000. The water of low and average years is all required for irrigation. It could be utilized for power as it comes from the reservoir, but would be available only six or eight months of the year, and the head would vary from 60 to 200 ft. There has been no power development here as yet.

A large amount of power might be obtained during the irrigation season at the Elephant Butte dam in New Mexico, but usually during two or three months of the winter, there would be no power. The available head will vary from 65 to 185 ft., and the maximum quantity of water drawn will be about 2,500 sec.-ft. During eight months of the year it would be possible to develop from 20,000 to 30,000 hp. The development of power was considered in designing the dam, and six 5-ft. power outlets were installed.

On the Shoshone project, Wyoming, a masonry dam rises about 250 ft. above the river bed. This dam furnishes a storage reservoir of about 450,000 acre-ft. capacity, and water is stored primarily for irrigation purposes. The flow of the stream, however, when thus regulated is greater than required for the irrigable lands and will furnish a surplus of water that can be used for power purposes during the winter. The river falls rapidly below the dam site, and from 25,000 hp. in winter to 40,000 hp. in summer is feasible. With the high dam and a large reservoir already constructed, together with the proximity of limestone, sulphur, coal and phosphate rock, the Shoshone location constitutes one of the best localities for the establishment of electrochemical industries.

An investigation has been made of a large water-storage and irrigation project at the head of the Sacramento Valley, with a high dam at Iron Cañon near Red Bluff, Calif. The quantity of water available would vary from 3,700 sec.-ft. to about 5,000 sec.-ft., and the head would vary from 60 to 130 ft., furnishing some 25,000 to 35,000 hp.

Large power possibilities exist near the outlet of Flathead Lake, Montana. The flow is rarely less than 4,000 sec.-ft., and this can be increased to 10,000 by a dam converting the lake into a storage reservoir. Such a dam would produce a head of 340 ft. and make practicable the development of from 200,000 to 300,000 hp.

The Reclamation Service in coöperation with the State of Oregon conducted an elaborate investigation in 1914 of the power and irrigation possibilities that could be developed by the construction of a dam in the Columbia River at what is known as "Five Mile Rapids," near The Dalles. At this point the Columbia River channel suddenly reduces from a width of about 1,800 to 150 ft. and continues between two rock walls in a very narrow and deep channel. The plan proposed is to build a dam at the narrow neck where the river first enters this gorge and to excavate a power canal to a power house 1½ mi. below. The quantity of water available varies between 50,000 and 1,000,000 sec.-ft. The head for plant operation will range from about 45 to 105 ft. Nearly 480,000 hp. could be developed continuously, with the possibility of additional large blocks of power for a part of the year. It is estimated that this project would cost about $50,000,000.

At the Priest Rapids on the Columbia River above the mouth of the Snake River an average head of 60 ft. can be obtained, which with a minimum discharge of about 40,000 sec.-ft. gives over 200,000 hp. the year around.

Tidal Currents in the Bay of Fundy as a source of power are being investigated by engineers, according to a report by United States Consul Henry S. Culver, St. John, New Brunswick. The plan at present under investigation is the development of power from the swift tidal current in Minas Channel opposite Cape Split. The velocity of the tidal flow in Minas Channel is eight to ten knots. It is stated that a market for the power when developed may be found in cities with an aggregate population of nearly half a million, located within a radius of 100 mi.

*From an address before a water-power conference of the American Institute of Electrica' Engineers and the American Electrochemical Society, Washington, D. C., Apr. 27, 1916.

†Director and Chief Engineer, United States Reclamation Service, Washington, D. C.

Building a Big Dam in Wilds

SYNOPSIS—A 70,000-cu.yd. gravity-section concrete dam is being built in Quebec Province 50 mi. from a railway. Part of the first great important storage and stream-control scheme ever attempted for power in America—that of the St. Maurice River, on which are the important hydro-electric plants at Shawinigan and Grand' Mère. Brief outline of the design of dam and notes on organizing contractors' forces for heavy construction and difficult transportation.

Designs and preliminary work have been completed for the construction of a 1,720-ft. concrete dam and the creation of a huge storage reservoir at the headwater lakes of the St. Maurice River in Quebec. The contractor is now engaged in the difficult work of providing

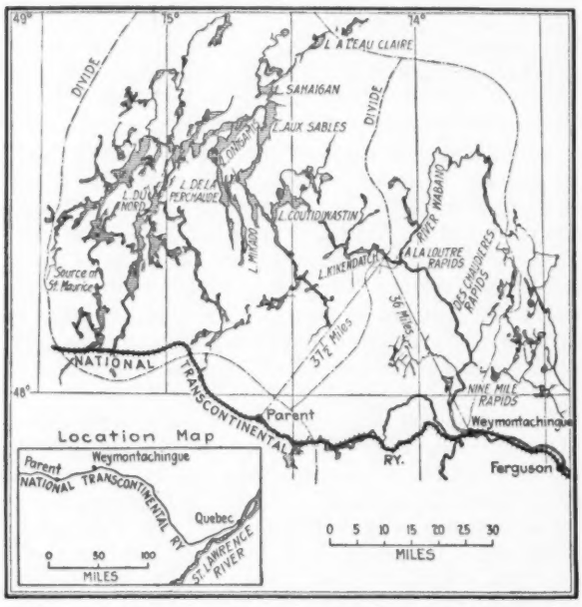


FIG. 1. MAP OF ST. MAURICE RIVER HEADWATERS

means of transportation for some 25,000 tons of material to the site. The progress thus made on the first great storage and river-control project for power in America actually to be undertaken (excepting the much smaller works on the Rangeley Lakes of Maine in the headwaters of the Androscoggin, as described in *Engineering News*, Mar. 9, 1911) is described in the following paragraphs.

Since the Quebec Streams Commission was organized, the control of the St. Maurice River has been the most attractive river-control project in sight, because of the important water powers on that stream and the marked improvement obviously possible. The records of daily flow at Shawinigan Falls showed a minimum of 6,000 cu.ft. per sec.—representing 0.37 sec.-ft. from each square mile of drainage area.

The early studies pointed to the vicinity of La Loutre Rapids (Fig. 1) as the logical place for a storage and control dam—at the lower end of a long intricate chain of lakes. The dam site is in entirely unsettled country, 37½ mi. in an air line north of the division point Parent on the National Transcontinental Ry. (Fig. 1) and 45 mi. from the junction of the Manuan and St. Maurice Rivers. Some 160 billion cubic feet could be stored, making a flow of 12,345 sec.-ft. for 150 days, or 6,172 sec.-ft. for 300 days. It was shown that the river could be regulated for 15,000 sec.-ft. at Shawinigan, leaving an over-supply in a very low year. The minimum flow in the lowest year (1906) was under 15,000 sec.-ft. for 255 days, with an average of 8,558 sec.-ft. during that time. But it was decided to regulate for only 12,000-sec.-ft. flow, in order to allow for loss of water in the 220-mi. flow to Shawinigan and to meet needs for floating logs at times when such water is not needed for power.

The important powers benefited are: Shawinigan (82,000 hp. at present, 164,000 future), Grand' Mère (41,000 hp. original, 82,000 future), La Tuque (32,300 hp. present and 78,000 future). These give a prior possibility of 155,300 hp. and a definitely planned extension to 324,000 hp. The figures quoted are based on fall and flow, with wheels of 80% efficiency.

Preparation of plans for the dam was intrusted to J. W. Thurso, with Edward Wegmann and J. M. McCarty as consulting engineers. The investigations in the field and the designing were under the direction of O. Lefebvre as Chief Engineer.

Test borings showed solid rock underlying the site. The plain gravity type was selected, and sliding gates were adopted. The profile was fixed after assuming an ice pressure of 50,000 lb. per lin-ft. acting at the crest level of the overflow weir; foundation uplift was neglected. The dam is to be 1,720 ft. long, of four straight sections (Fig. 2), with 851 ft. of spillway. Among the notable features are a movable sluice for logs and rubbish, a 375-ft. measuring weir and means for heating the gate chambers. A power house with two electric generating units was originally designed, but this was later eliminated—partly because the variable head (0 to 50 ft.) did not give good hydraulic conditions at the dam and partly because hand operation of gates will be satisfactory.

Inaccessibility of the Dam Site

The contract for the construction of the storage dam at La Loutre was awarded in July, 1915, by the Quebec Streams Commission to the St. Maurice Construction Co., Ltd., Montreal. The St. Maurice Construction Co. entered into an arrangement with Fraser, Brace & Co., Ltd., Montreal, for the supervision and execution of the contract.

The most unusual feature of the work is its great distance from the railroad. The dam site is situated 50 mi. (by route) north of the National Transcontinental Ry., being about equally distant from the stations known as Weymontachingue and Parent, both of which are very small communities, the first named being 75 mi. north of La Tuque, which was, at the beginning of the work, the nearest post office. The only train running over the new Transcontinental line between La Tuque and Weymontachingue was a mixed train that went on Tuesdays and Thursdays. The nearest telegraph operator was also at La Tuque, so that the communications with the work were extremely slow and difficult. Communication be-

Downstream Elevation

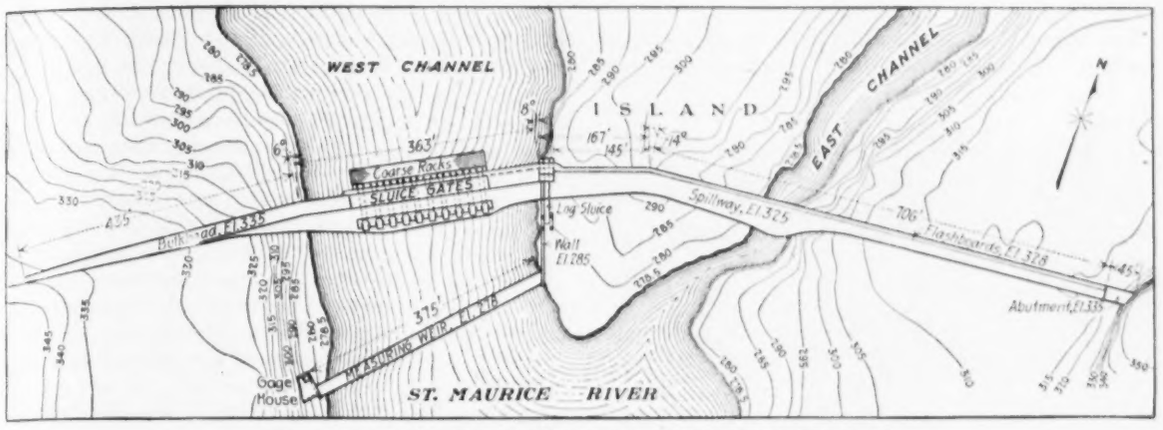


FIG. 2. PLAN AND ELEVATION OF ST. MAURICE CONTROL DAM

tween the railroad and the dam site was by means of canoes leaving the Transcontinental Ry. at Manouan, a place opposite Weymontachingue and near the crossing of the Manouan River. There was no station at this point, but all trains stopped there because of the existence of two trading places and three or four houses.

To reach the dam site at La Loutre from Manouan was a two-day journey by canoe. The first 30 mi. of river travel above Manouan was fairly smooth going, there being only one small rapid, up which the guides poled the canoes, the passengers taking to the bush for a short distance. At the 30-mi. point are the Chaudière Rapids, with a fall of approximately 30 ft. There are six other falls of greater or less descent in the remaining 20 mi. between this point and the dam site. All of these seven falls had to be passed by portage or carry.

The route up this river has been in use for a great many years, the goods of the Hudson's Bay Co. having been transported by this route to reach stations at Kikendatch and other points farther up the river. The country on both sides of the river is quite rough, being broken up by ridges and hills in every direction. The hills are from 100 to 500 ft. high, and the entering streams run in gullies of considerable depth, making travel along the banks extremely difficult. The soil is light and sandy, and the whole country is covered with a rather small growth of jack pine, spruce, poplar and white birch. The country is said to have been burned over, 50 or 60 years ago. Slight fires at more recent dates are indicated by limited areas completely grown up with small white birch. None of these show effects of very recent fires, and as a matter of fact, the country during the past few years has been very carefully patrolled by fire rangers employed by the St. Maurice Hydraulic Association. This work of the fire rangers is extremely vital to the preservation of the timber and has been organized in a very efficient way.

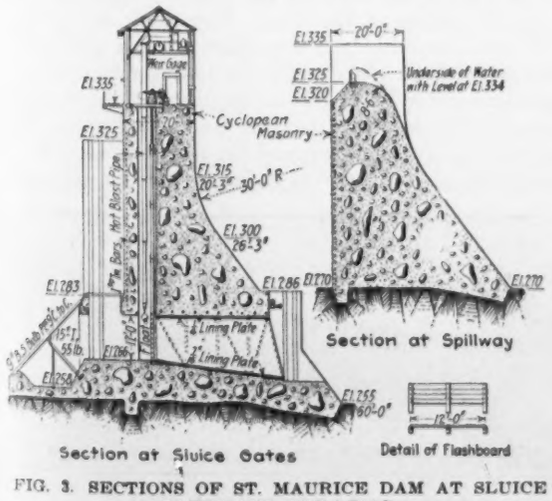


FIG. 3. SECTIONS OF ST. MAURICE DAM AT SLUICE GATES AND SPILLWAY

Selecting a Transportation Route

The contractors virtually had a choice of two routes for reaching the place of work from the Transcontinental Ry. The route from Parent was investigated by competent railroad engineers. It was found to offer a line of easy grades and curves, but through a country so thoroughly burned that there was not enough timber in it even to provide the ties. It was estimated that the construction of a railroad through this country would require a line at least 48 mi. in length and that this could not be completed in time to permit any construction work at the dam during the summer of 1916. The second route was adopted by the contractors, utilizing river transportation for the 30 mi. on the St. Maurice River above Manouan or Weymontachingue as far as the Chaudière Rapids; a railroad 20 mi. long was required from Chaudière to the dam site at La Loutre, following the west bank of the St. Maurice River.

Railroad surveys were begun in August, 1915, the temporary headquarters being established in tents at Manouan. The survey parties were served by canoes carrying camp equipment and supplies up the river. A telegraph office

was established at Manouan, and within a very short time a siding was built close by for the contractor's service, and a small station was erected there. This station is known as Sanmaur. The railroad survey developed a good many difficulties because of the very rugged nature of the country, the impossibility of seeing any distance in the thick woods and the necessity of putting through the line at a low cost.

The estimated weight of material to be taken into the dam site is 25,000 tons. It is easily seen that this amount could not be transported by highway unless a good road were constructed, which would cost as much at least as a cheap railroad line. As for the method of all-river transportation, including portage, it was found to be barely possible to get in enough provisions to begin the railway work by this method.

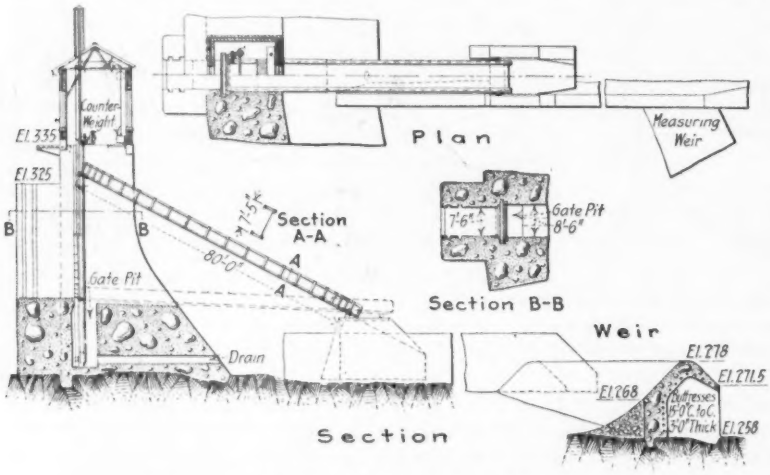


FIG. 4. PLAN AND ELEVATION OF LOG SLUICE

The railroad construction forces were sent up the river, beginning Sept. 12, 1915, and construction was started as rapidly as these forces could be taken in and supplied with provisions and equipment. It was found impossible to get horses in until the middle of October, but eventually during the fall over 800 men and 70 horses were at work. With the exception of the first two miles of railroad, the work proved to be extremely light. The sandy soil was easy to excavate, and very good timber for ties and trestles was found within a mile of the right-of-way.

The right-of-way follows the west bank of the river, as mentioned, and from Chaudière to within a mile of the dam site it runs through property owned in fee simple by the Brown Corporation, La Tuque. The corporation granted the right-of-way for contract purposes on favorable terms and has coöperated effectively with the contractor in every way. A telephone line was pushed through from the Transcontinental Ry. at Manouan to the dam site in 3½ mo. This line follows the river closely on the west bank as far as Chaudière, then follows the right-of-way to the dam site, with a short branch line running to the construction power-house site at La Loutre. The line is a metallic circuit and is built for the Streams Commission for permanent use in connection with the operation of the storage works. The contractor has the privilege of using the line during construction, and it has already proved to be almost indispensable.

The river transportation was begun with 18-ft. freight canoes. Portable gasoline motors were attached to them, and supplies for the early telephone and survey work were carried up by them. Gasoline motor boats were next brought up, being of the tunnel-stern type. The river was very low, and motor boats of the ordinary type were considered unsuitable because of the numerous rocks in the river bed. It was soon found, however, that Indian pilots who knew the river could avoid these rocks and that the usual type of motor boat could be used. The employment of pilots made possible running the boats at higher speeds, so that the trip between Manouan and Chaudière was soon cut down to 5 hr. going up and 3 hr. coming down.

Three ordinary scows of from 15 to 25 tons' capacity were constructed at Manouan for the transportation of supplies, and seven open scows were purchased lower down on the St. Maurice River. These scows, being only 10 ft. wide and 60 to 75 ft. long, were brought to Sanmaur on railroad cars and placed in service much more quickly than new boats could be constructed. These boats are practically bateaux; they steer easily by a 50-ft. oar in the hands of one man and are guided very readily even in the crookedest parts of the river. The contractors have adopted this general type and have now under construction a number with a freight capacity of 40 tons each. These scows are of extremely shallow draft and are eminently suitable for the service required, even at very low stages of the river. One small steam tug of the twin-propeller type was taken up and used during the fall of 1915. The rest of the towing was done by the gasoline motor boats. This equipment of boats carried in approximately 900 men for the railway work, about 65 horses, all plant required for the railroad construction and most of the supplies for the winter forces.

FIG. 5. EAST AND WEST CHANNELS OF ST. MAURICE RIVER AT LA LOUTRE DAM SITE

The river throughout most of the 30 mi. that had to be navigated is very crooked, with a large number of sand bars. The current averages 2½ mi. per hr. at ordinary stages of the water. About 12 mi. above Sanmaur there is the Nine-Mile Rapid, which is ½ mi. in length and in which the river has a fall of 3 ft. Above this rapid the current is swift for a distance of 7 mi. The freight boats could not well be towed through the Nine-Mile Rapid, so they were pulled for a distance of 2,500 ft. by a cable operated by an ordinary hoisting engine set up on the bank. The channel through the rapid was considerably improved by breaking up a number of boulders with dynamite and pulling the large fragments ashore by winches. Even after this improvement the rapid was always difficult to navigate. Careful surveys have now been made, and the channel will be further improved in the spring. It is not likely that the use of the hoisting engine will be done away with altogether, but it is thought that considerable time may be saved in pulling the boats up, and this will reduce the number of boats otherwise required for the service.

Hydro-Electric Power for Construction

A hydro-electric plant of 1,150 hp. is being erected by the contractors to furnish power for the construction work. The location selected is the La Loutre Rapids, 2¼ mi. below the dam site. The machines to be installed have two 39-in. wicket-gate wheels per unit, each unit to furnish 575 b.hp. at 150 r.p.m. with a net head

FIG. 6. HEAD OF CHAUDIERE RAPIDS

of 15 ft. The generators are 350-kv.-a. three-phase 2,400-volt 60-cycle alternators with 14-kw. 125-volt exciters mounted on the main shafts.

The power house is being built of reinforced concrete and extends as a dam across a small channel of the river between two islands. Another channel is used as a spillway. The whole structure sits on solid rock, the draft tube and tailrace being excavated behind coffer-dams built in November, 1915. It is expected that this plant will be in service by May, 1916. The contractors have already delivered at Sanmaur most of the construction plant, and most of this has been transported as far as Chaudière. The power-house machinery has been delivered at the site of the power house.

A large item of expense has been the 56-lb. rails for the railway line, which is being built standard gage. Oil-burning locomotives with standard-gage flat-cars and box-cars have been secured. The oil-burning locomotives are necessary to eliminate the danger of fire in the woods alongside the right-of-way.

The quantities of excavation at the dam site are comparatively small, being about 7,000 yd. of rock and 14,000 yd. of earth. The net quantity of masonry in the dam will be about 70,000 yd. A quarry has been located within a thousand feet of the dam site for obtaining concrete stone. There are good sand banks along the line of the railway close to the dam site.

The rock from the quarry will be dug with a 60-ton Marion steam shovel. It will be crushed by a 36x54-in.

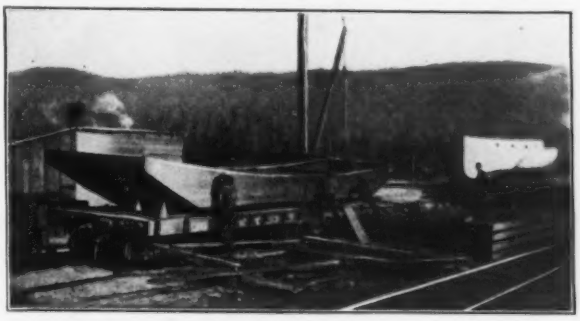


FIG. 7. CONTRACTOR'S FREIGHT BARGE AND MOTOR BOAT

Buchanan jaw crusher as a primary breaker, with a No. 7½ Telsmith secondary crusher and two small Austin gyratory crushers for the tailings. This crusher plant has a very large capacity compared to the quantity of crushed stone required. The large size of the primary crusher was decided upon so that the stone could be taken direct from the steam shovel without rehandling or breaking. It was estimated that the 36x54-in. primary breaker would easily take in any stone that could be handled by the steam shovel using a 2- or 2½-yd. bucket. Six-yard standard-gage cars loaded by the steam shovel will dump directly into the primary breaker.

The combination mixing and crushing plant is to be situated on a steep side hill very close to the dam and on the downstream side. It is planned to place the concrete and to handle the large stones, as well as forms, steel gates, gate-operating machinery, etc., by two overhead cableways and four derricks, the latter standing on cribs on the downstream side of the dam.

Unwatering the Site; Winter Work

Next to the problem of providing transportation to the dam site is the problem of unwatering the dam foundations. The river is divided into two channels at the dam site—one on the west side of the small island being 350 ft. wide, and the other on the east side of the small island being about 120 ft. The contractors plan first to shut off the small, or east, channel in the spring of 1916 and build the dam up to El. 1,278, which is ordinary low-water level on this side of the river. When this has been done, it is proposed to build a coffer-dam across the main, or west, channel high enough to force the water to pass over the dam in the small east channel during the entire construction of the dam in the west channel. The part of the dam in the west channel contains the 10 sluice gates; and when this part has been completed, the sluice gates will be opened and the section of the dam in the east channel will be carried up to full height.

There is a depth of 25 ft. of water in the west channel at ordinary stages of the river, and downstream coffers

FIG. 8. TRESTLE AND EMBANKMENT ON CONTRACTOR'S RAILWAY AT MILE 4

as well as upstream coffers will be required. Diamond-drill borings taken by the commission previous to the letting of the contract indicated a good rock foundation (Laurentian gneiss) all across the dam site, covered by approximately 5 ft. of sand and gravel for the entire length except on the west shore, where the cover has an average depth of 15 to 18 ft.

In addition to completing the telephone line and grading 13 out of the 20 mi. of railroad and beginning construction of the temporary power house the contractors have already erected a number of camps and dwellings at the dam site. Grading of the heavy cuts has been continued along the railway, and the construction of trestles has proceeded during the winter without interruption. The right-of-way has been cleared throughout its entire length, and the portions not yet graded are extremely light work that proved practically impossible of accomplishment after the winter weather set in. Cutting out timber for all purposes at the dam site has been carried on during the winter. About 4,250,000 ft. b.m. has been taken out and delivered inside of booms on the ice at a point on the river a short distance above the dam site. A sawmill has been erected and saw machinery installed at the dam site; all the lumber needed will be cut here.

A certain amount of transportation has been necessary during the winter, and this has been over the ice for the 30 mi. between Sanmaur and Chaudière and over the right-of-way from Chaudière to the dam site. There has been heavy snow all over this country since Nov. 15. The river choked up with snow and ice at two points on Nov. 16, making further navigation impossible. The river road did not become suitable for teaming until Jan. 1. A few teams were driven over the road during December with light loads, but there were several weeks when the only means of communication was by walking or the use of dog teams. The ice leaves the river between Apr. 20 and May 5.

New Concrete Building System

To reduce the large item of form cost in concrete building work, a new system has been developed in which floor forms are eliminated. The floor-slabs are cast on the lower floor and are hoisted thence to place; the columns are cast under the slabs when raised. The hoisting is done by a series of jacks, one at each column, actuated in unison so that a large area of slab can be handled as a unit. Albert Peltzer, of 6726 Laflin St., Chicago, the inventor of the system, gives the following condensed description: "In this system the foundations and the first floor-slab are finished in the usual manner. Directly on top of the first slab the second floor-slab is cast; the third is cast on top of the second, and the two slabs are left to harden. Now, light structural-steel columns are placed in position, holes having been left in the slabs for this purpose. Next, jacks resting on these columns and attached to the slabs are applied, and the two slabs are raised to the proper height for the lower one. Forms are placed around the columns under the slab, and concrete is poured in from the top, the structural steel now forming the reinforcement of the column. The same operation—hoisting the slab and casting the columns—is repeated for the third floor-slab. Then if the building is to be higher, two more slabs are cast on the upper one, the columns are extended and the work continued as for the lower two slabs." Mr. Peltzer has designed for this service pneumatic jacks controlled from one point.

The process of building in this way has been patented. The inventor intends to rent the required apparatus to builders, and furnish the services of a skilled operator. Even a very large factory plant, it is claimed, can be built in such order of operations as not to employ more than 60 jacks at one time, costing less than $5,000. The saving over present methods is claimed to be at least 1c. per cu.ft.

Steel Aqueduct for Sewer

An original structure has just been built by the City of San Antonio, Tex., for a 6-ft. outfall sewer. Where this crosses a river valley, the concrete sewer section is changed to a 6-ft. steel pipe supported on a series of piers. The pipe is trussed by riveted steel queenpost trussing, and in this way spans of 81 ft. 10 in. are made possible. The pipe is hung directly to the vertical hangers of the trusses (there being no floor system), and

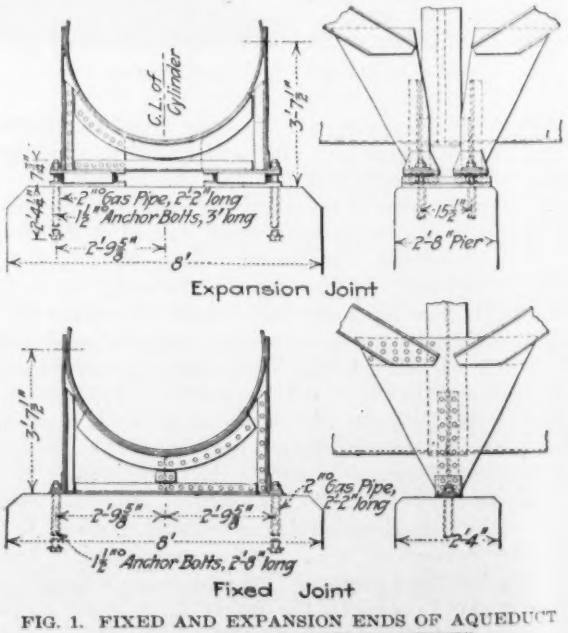
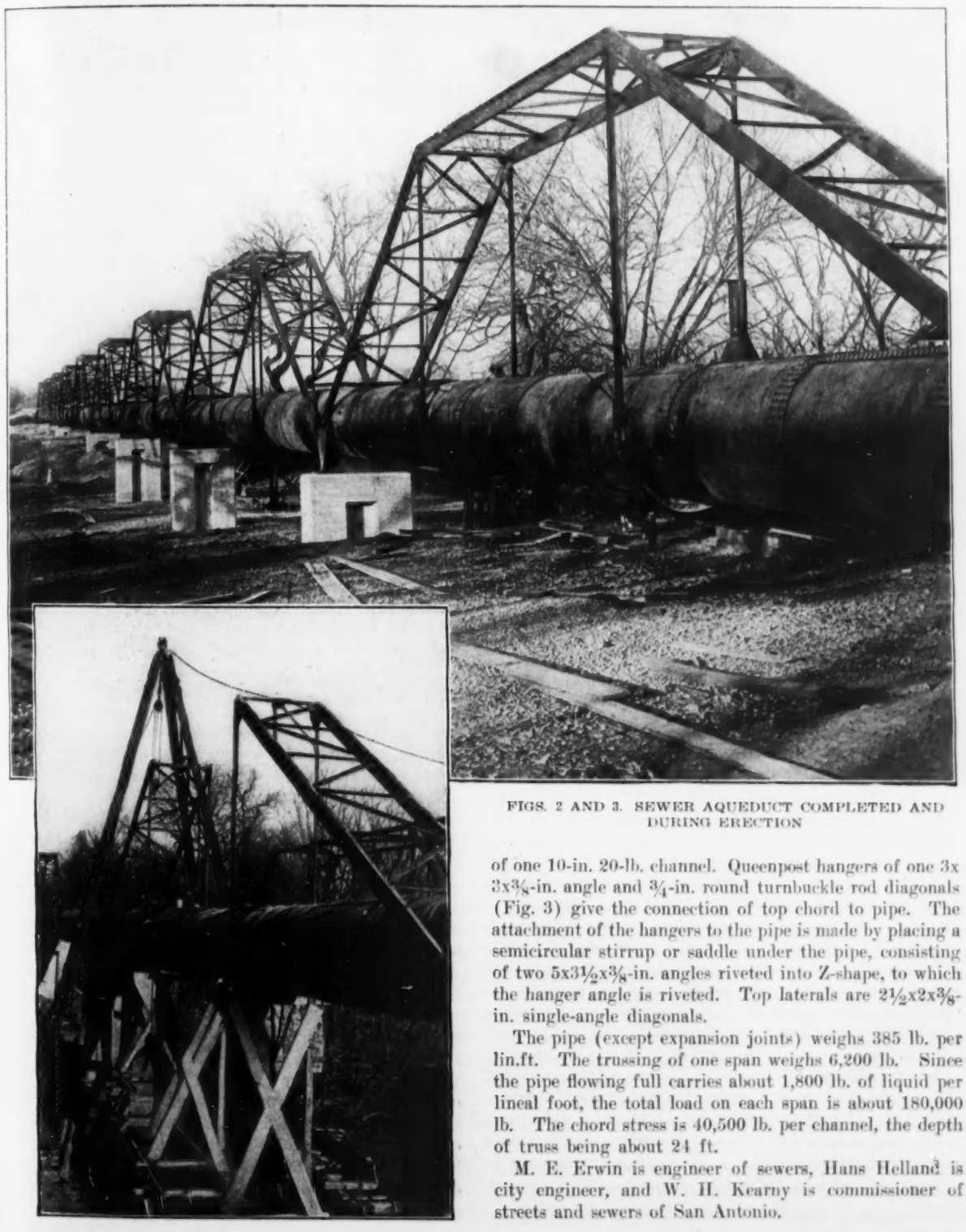


FIG. 1. FIXED AND EXPANSION ENDS OF AQUEDUCT TRUSSES FOR SAN ANTONIO SEWER

itself forms the bottom chord of the trusses. The Chicago Bridge and Iron Work built the steelwork.

Reference to Fig. 1 will give the details of the pipe connection with the concrete section. A packed sliding joint is used at these points. There is a 30-ft. span at each end, and between the ends are 18 spans of 81 ft. 10 in. each. The city engineering department designed an ingenious pier type for the support of the trussed spans, as shown in Fig. 2. The pier consists of two 3x3-ft. concrete columns set on a base plate, connected by a 12-in. diaphragm and capped at the top. The steel spans have expansion on alternate piers. A roller expansion shoe is used. As shown in the view in Fig. 2 the trussing consists of a pair of top chords each made



FIGS. 2 AND 3. SEWER AQUEDUCT COMPLETED AND DURING ERECTION

of one 10-in. 20-lb. channel. Queenpost hangers of one 3x3x⅜-in. angle and ¾-in. round turnbuckle rod diagonals (Fig. 3) give the connection of top chord to pipe. The attachment of the hangers to the pipe is made by placing a semicircular stirrup or saddle under the pipe, consisting of two 5x3½x⅜-in. angles riveted into Z-shape, to which the hanger angle is riveted. Top laterals are 2½x2x⅜-in. single-angle diagonals.

The pipe (except expansion joints) weighs 385 lb. per lin.ft. The trussing of one span weighs 6,200 lb. Since the pipe flowing full carries about 1,800 lb. of liquid per lineal foot, the total load on each span is about 180,000 lb. The chord stress is 40,500 lb. per channel, the depth of truss being about 24 ft.

M. E. Erwin is engineer of sewers, Hans Helland is city engineer, and W. H. Kearny is commissioner of streets and sewers of San Antonio.

City Planning at Cebu

By R. C. Hardman*

A few years ago the City of Cebu, Philippine Islands, was visited by two disastrous conflagrations which practically wiped out the retail business district, leaving intact but a few of the most substantial stone buildings. The work which followed in the line of replanning after the second fire presents some very remarkable features in the way in which privately owned property was handled.

Cebu is one of the oldest cities in the Islands, having been the landing place of Magellan in 1521. The streets were of the cow-path type, varying in width from the span of a man's outstretched arms to about 30 ft.

Modernizing Streets of Burned-Over Area

As the Insular government was improving the harbor to the extent of about half a million dollars, it was decided by the authorities to make an effort to modernize the burned area. One of the first steps taken was the appointing of a committee to devise ways and means. Rebuilding operations were prohibited until the report of the committee with surveys, plans, etc., was rendered.

The area burned over by the two fires was 29.1 acres, with street frontages of 15,766 ft., and as will be seen by Figs. 1 and 2, the street system and the arrangement of individual lots were complicated. The property was of course valuable. Modernizing the area meant, naturally, the straightening and widening of the streets or the location of new ones on a modern system. The only feasible rearrangement of streets was necessarily one in which practically no attention could be paid to the old lines. And obviously, any radical departure from the existing arrangement would play havoc with the prevailing ownership of property. As the work had to be done very economically if at all, no buildings of any great value could be condemned. Consequently the new streets must be governed in their location by the existing valuable buildings, as well as by the location of the adjacent and connecting streets and plazas. For this reason the main street, Calle Magallanes, was left practically the same in alignment, but with its width increased to 30 m. Similarly, the streets bounding the area were left practically as before. Within the boundaries of the area no attention was paid to existing streets or private property other than buildings, with the exception noted. A comparison between the old and new arrangements is well shown in Fig. 1, wherein all buildings are represented.

Changing Size, Shape and Location of Lots

Up to this point nothing remarkable was done, as all usage of private property could have been taken care of by condemnation. However, in the disposition of private property a very unusual method was employed. The problem next to be solved was the changing of the size and shape of each of 250 lots and refitting them into the newly established blocks. The area of the private property was 117,805 sq.m., which was to be placed within the 100,000 sq.m. available under the new arrangement. The street frontages were likewise to be reduced from 4,805.5 m. to 4,699.9 m. The reduction in area of 15.1% and the loss in frontage of 2%, furthermore, had to be accomplished without cost. A similar attempt in the United States would, without doubt, have been attended by a sharp rise in values and endless litigation.

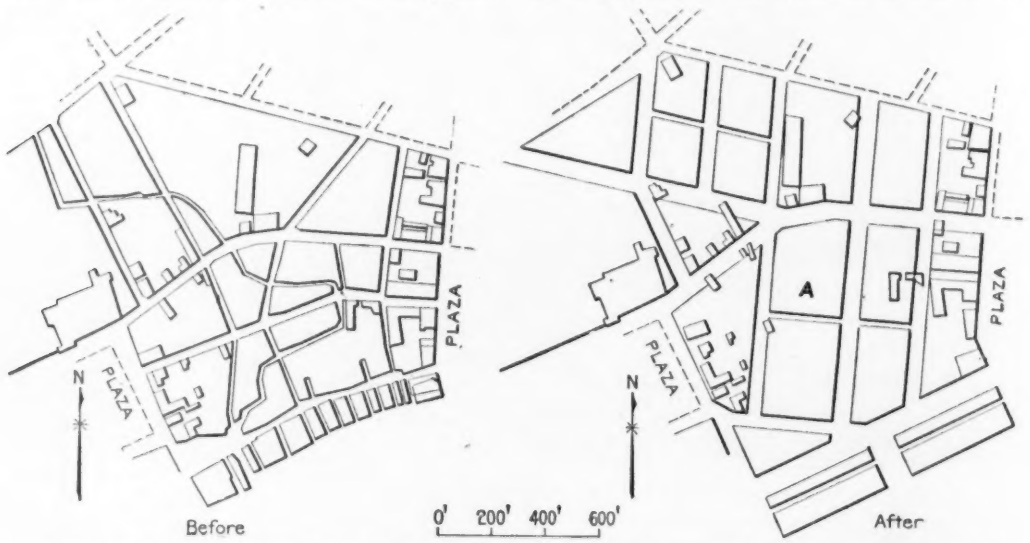


FIG. 1. REARRANGEMENT OF STREET SYSTEM IN THE CITY OF CEBU IN THE PHILIPPINES
The new streets are 15, 20, 24 and 30 m. wide

As a first step in the process the area of each lot was determined by planimeter, after being surveyed, and its frontage and *average* depth determined by scaling. Tables were prepared showing these results, with additional columns for old value, new depth and new frontage. From Fig. 2, which shows the typical arrangement of lots, it will be seen that the application of the methods employed was largely a matter of judgment in a great many cases. In other cases, such as lots entirely surrounded by other lots and lots having frontage on alleys, the method could not be applied at all.

The next step was the preparation of a table or scale of values. An arbitrary value per front foot for each successive 10 ft. in depth was assumed. Thus the first 10 ft. was assumed to have a value of $20 per front foot, the second 10 ft., $18; the third 10 ft., $16, and so on in decreasing amounts. A lot 30 ft. deep would thus have a value of $54 per front foot. The assumed values were flat, no distinction being made between the high and low real

*Colorado Springs, Colo.

values. It was further arbitrarily assumed that the wider and straight streets would enhance the value of the property by a flat 10 per cent. From these assumptions the following value scale was prepared:

Assumed Old Value	Depth in Feet	Assumed New Value
$20.00	10	$22.00
38.00	20	41.80
54.00	30	59.40
68.00	40	74.80
80.00	50	88.00
90.00	60	99.00
98.00	70	107.80
104.00	80	114.40
108.00	90	118.80
110.00	100	121.00
112.00	110	123.20
114.00	120	125.40
116.00	130	127.60

The values given are not the actual ones used, but serve to illustrate the principle involved. For depths other than shown the values were interpolated.

The value scale was used as follows: Consider an old lot 30 ft. in depth and having a frontage of 50 ft. Its value per front foot would be $54 and its total value 50 × $54, or $2,700. This particular lot is to occupy in its new location a space 80 ft. in depth. Under the "new value" heading a lot 80 ft. deep is found to have a value of $114.40 per front foot. Therefore the frontage of the new lot would be $2,700 divided by $114.40, or 23.6 ft. Its new area would be 1,888 sq.ft., as against its original area of 1,500 sq.ft. A typical table follows:

		Old				New		
Name	Lot No.	Front, Ft.	Depth, Ft.	Area, Sq.Ft.	Value	Front, Ft.	Depth, Ft.	Area, Sq.Ft.
Juan Cui....	2	26	30	780	$1,404	18.8	40	752
Pedro Cuan..	3	47	120	5,640	5,358	46.8	80	3,744
J. Bulayat...	7	8	75	600	808	7.0	80	560
Jose Cadonog	9	20	20	400	760	12.8	30	384
D. Macapugay	13	12	110	1,320	1,344	11.8	80	944
V. Leon.....	15	50	30	1,500	2,700	22.3	100	2,230

It will be seen from the table that the owner of a deep lot lost and the owner of a shallow lot gained, in area, by the readjustment. The cases mentioned are not actual ones, but merely show the method used. The only lots that remained in the same positions, approximately, were those upon which permanent buildings were situated, and these often suffered changes in area and boundaries. The majority of the lots were materially changed in location, and a number found themselves several hundred feet from their original positions. A glance at Fig. 2 will show that this must necessarily have been true, as there is absolutely no resemblance between the "Before" and "After" of the sketch. Interior lots were placed upon alley frontages in the new arrangement—the alleys, 5 m. in width, being wider than many of the old streets.

One New Lot Composed of Nine Old Ones

To have made these extremely radical changes legal in the ordinary way—that is, by the transferring of small parts of original lots to the numerous owners of the new conflicting lots—would have entailed an almost endless amount of computing of intersections, bearings, distances, etc. For instance, the lot designated *A* in Fig. 2 is made up of parcels of nine old lots. To have made the transfer would have required nine separate descriptions and maps and nine separate deeds.

In order to eliminate this work the committee in charge was empowered by an Act of the Philippine Commission to "acquire title to all lands within said area by gift, session or transfer from present claimants of said lands, and having secured title to said lands, is empowered to make application to the Court of Land Registration to have the title of all lands within said area registered and confirmed in the name of said committee. . . . After the title to said lands shall have been registered in accordance with the preceding paragraph, the committee shall convey title to the person or persons or corporations entitled thereto in accordance with the allotments agreed upon and shown on plan filed with the application in the Court of Land Registration."

In addition to the original burned area a plat of ground being reclaimed by the harbor improvement was also platted. This area is shown in the lower right-hand corner of the "After" section of Fig. 1.

The work seems to the writer to be remarkable, not from a technical standpoint, but as an example of what appears to be high-handed juggling of private property.

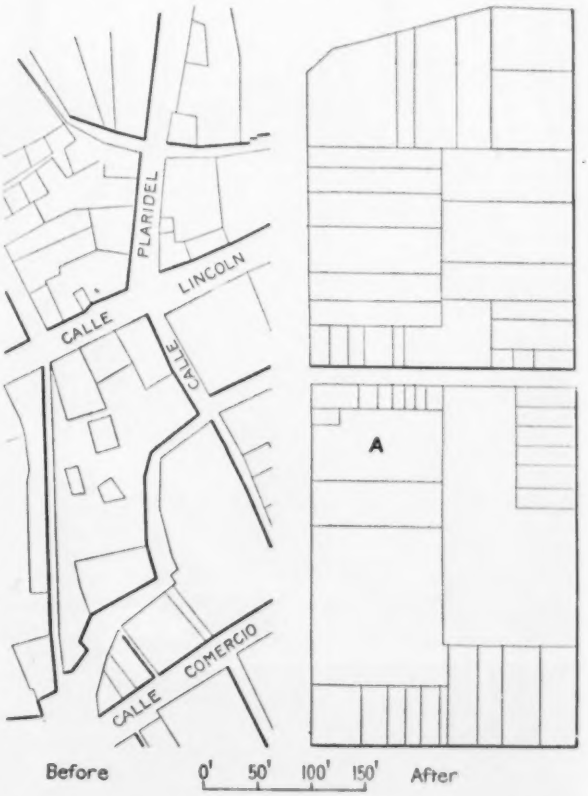


FIG. 2. REARRANGEMENT OF LOTS IN CEBU

The individual lots were changed in almost any manner that would insure their fitting into the blocks provided for them, much in the same way that a jigsaw puzzle is pieced together. In fact, small pieces of paper representing the lots were actually used. Small discrepancies in area were adjusted, or distributed, over adjacent lots. To anyone who has been engaged upon similar work in the United States, where the question of private property is such a bugbear and one of the most difficult obstacles to be overcome, the work will stand more as a problem in human nature than one of engineering.

The committee having the work in charge consisted of the Consulting Engineer to the Commission, J. W. Beardsley; the Provincial Supervisor, T. Warren Allen; the Provincial Fiscal, Sergio Osmena, and the Municipal Presidente. The work was done by R. F. Moss and the writer under the immediate direction of T. Warren Allen.

National Guard Engineer Corps

By Louis D. Koop*

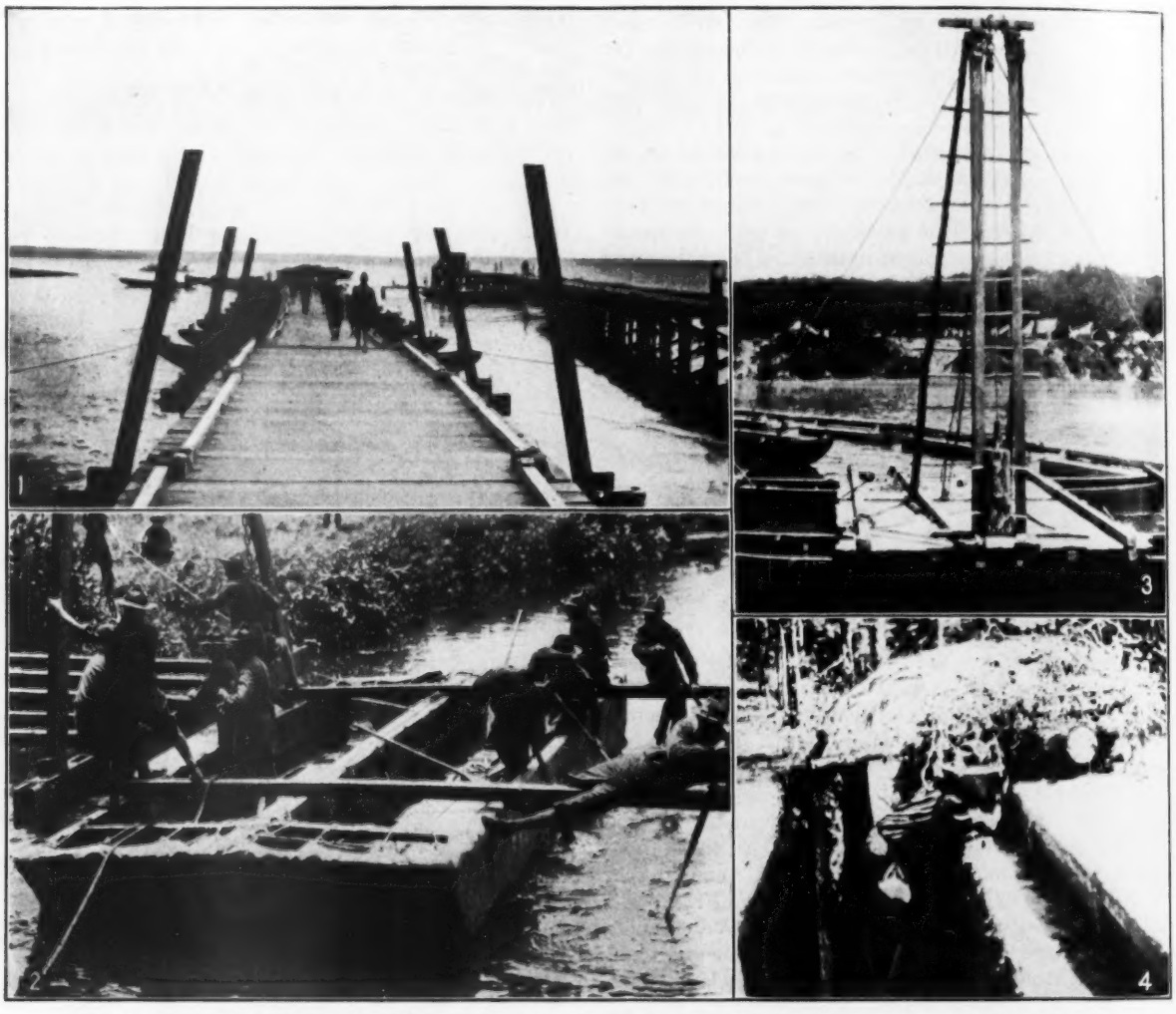
Few civilian engineers seem to be aware that there now exist in a number of the states National Guard Corps of Engineers, in which they can get the requisite training, drill and instruction to fit them for immediate service as military engineers in case of necessity. There is, however, a serious deficiency in number of companies and an opportunity to improve the situation. The following is a list of the existing organizations:

State	Station	Strength
Colorado	Golden	1 company
Illinois	Chicago	1 company
Iowa	Iowa City	1 company
Michigan	Calumet	1 company
New York	New York City	2 battalions
Ohio	Cleveland	1 battalion
Oklahoma	Norman	1 company
Pennsylvania	Scranton and Philadelphia	2 companies

The land forces of the United States are divided into the mobile army and the coast artillery. As the basis of organization of the mobile army we have the division—a self-contained unit made up of all necessary arms of the service. At war strength it consists of about 22,000 men. Several divisions may be grouped in a field army. The War Department has prepared plans for organizing the mobile troops of the regular army and the National Guard into 16 divisions, of which 12 divisions comprise the National Guard. At present there is a deficiency of 13 battalions of engineers in the National Guard divisions, there being only eight pioneer and five ponton battalions. There is thus a splendid opportunity for engineers in states having no engineer troops to form and organize units.

One pioneer battalion of engineers is attached to a division and a ponton battalion to a field army. A pioneer battalion consists of three companies. For service with infantry divisions a pioneer company is organized as follows: 1 captain, 2 first-lieutenants, 1 second-lieutenant, 1 first-sergeant, 1 quartermaster-sergeant, 12 sergeants, 18 corporals, 2 cooks, 2 musicians, 64 first-class privates and 64 second-class privates—a total of 168 officers and men.

The engineer troops of New York State as now organized consist of a pioneer battalion and a ponton battalion known as the "22nd Corps of Engineers." These troops are armed, equipped and receive the same instruction and



FIGS. 1 TO 4. ILLUSTRATING ACTIVITIES OF 22ND CORPS OF ENGINEERS, N. G. N. Y., AT BELVOIR, VA.

Fig. 1—Heavy pontoon bridge construction. Fig. 2—Building canvas pontoon bridge. Fig. 3—Floating piledriver of pontoon equipment. Fig. 4—Trench with overhead cover

*Assistant Engineer, Department of Bridges, New York City; Lieutenant, Corps of Engineers, National Guard, New York.

drill as the U. S. Engineers, and under the supervision of a commissioned officer of the Corps of Engineers, U. S. A., detailed as inspector-instructor, and a sergeant from the U. S. Engineers.

The armory of the 22nd Corps of Engineers is at 168th St., near Broadway, New York City, Lieut.-Col. E. W. V. Lucas, commanding. Major F. W. Whitely is in command of the pioneer battalion, and Major W. S. Conrow is in command of the ponton battalion. Capt. R. S. Thomas, Corps of Engineers, U. S. Army, is inspector-instructor. Drills are held on Thursday and Friday nights.

During the year the training drill and instruction is divided into two periods—armory instruction and field training. The armory instruction is both theoretical and practical and is given during the period between Oct. 1 and May 1. The field training is entirely practical and covers outdoor drill and instruction given at camps, maneuvers, etc., during the period between May 1 and Oct. 1. Theoretical instruction consists of lectures, quizzes and examinations, held weekly and covering all military and engineering subjects. Practical instruction is given one night a week between 8:15 and 10:30 in the following subjects:

Military—Infantry drill, military courtesy, personal hygiene, care of rifle, care of uniform and equipment, tent pitching, rolling blankets and packs, signaling, sighting and aiming drill, indoor target practice, bayonet exercise, guard duty, map maneuvers, horsemanship.

Engineering—Reconnaissance-map reading, use of sketching board, map making, topographical symbols, visibility problems, photography, map reproduction.

Field Fortifications—Model trenches (sand box); model of overhead cover, models of revetments, models of obstacles, construction of flares, construction of alarms.

Bridges—Knots and lashings, loading ponton equipment, assembling pontons, rigging tackle, constructing shears and derricks, king-post bridges, trestle bridges, pile-driver construction.

Demolition—Precaution in demolition, distinguishing explosives, splicing powder and electric fuses, computation and placing charges, construction of mines.

The work covered during the field-training season is performed at the schools of application, target ranges, camps and maneuvers. It consists of infantry drill and exercises, target practice and the construction in the field of engineering works.

In 1915 the principal field training was received by each battalion during a period of two weeks at Belvoir Tract, Va., in joint camp with two companies of U. S. Engineers. Belvoir Tract is situated on the Potomac River about 15 mi. below Washington. This site is well adapted to engineer operations, having plenty of timber, and a river bordering on the camp site suitable for instruction in ponton work. The reservation is of sufficient area to permit full sway to be given in actual practice of pioneer operation, such as digging trenches, cutting timber and executing demolitions. All of the work done at this camp consisted of practical field engineering and was pronounced by all taking part as having been one of the most instructive camps in which they had participated. The accompanying photographs show the New York engineers at work.

A provisional company from the 22nd Corps attended the state camp at Fishkill, N. Y., for a period of a month last summer, laid out the camp site, constructed the water-works, built bridges, laid out and supervised the construction of a mile of trenches by the infantry, constructed land mines and dismantled the water-works. In this work the engineers were thrown on their own initiative and acquired valuable experience in coöperating with other arms of the service and gave an impression as to the true rôle of engineers.

From this it will be seen that the kind of men who are best qualified for this work and who should join engineer organizations are engineers, both field and office men, construction superintendents, and foremen and mechanics, such as carpenters, dock-builders, timbermen, riggers, iron workers and railroad men. It should also be understood that military engineers are soldiers first and engineers afterward. A large number of the officers and men of the 22nd Corps are practicing civil, mechanical and electrical engineers.

In New York men enlist for three years and are required to attend drills one night a week between October and May and to attend the field training camp for about two weeks in the summer. All arms, uniforms, etc., are furnished free of charge, and during the two weeks of field training, transportation, rations and all necessities are provided, with pay at a minimum rate of $1.25 a day for enlisted men. If a man is unexpectedly required to leave the city in which his company is located, he may be dropped or discharged and taken up again when he comes back, receiving credit for his previous service.

The training in punctuality, order and businesslike methods that are required in military service will make a man more valuable in civil life. There is everything to gain and nothing to lose by joining the National Guard.

California Has a Reserve Corps of Military Engineers

A general plan of organization has been perfected that provides for a "Civilian Volunteer Reserve Brigade of Engineers for California," to be officered and instructed by specially qualified engineers and retired United States engineer officers. There is to be one officer of the Army Engineer Corps as advisory head. The state has been divided into three sections, and one regiment of eight companies is provided for each section between Eureka and San Diego. These companies will have senior- and junior-grade engineers (civil, mechanical, electrical, mining and chemical) as commissioned and noncommissioned officers. General instruction in military engineering and infantry tactics will be given the officers preparatory to recruiting for the enlisted grade, which grade will not be recruited at present. This will remain a civilian-engineer organization prepared to volunteer its services in case of need. Training will not interfere with private business and will follow, as much as possible, instructions as approved by United States Army engineer officers. During the coming year, at least, resignations will be accepted promptly in case it is found advisable to give up the work.

Company headquarters have been made and recruiting officers appointed for San Francisco, Sacramento, Grass Valley, Eureka, Oakland, Berkeley, Alameda, Palo Alto, San José, Stockton, Merced, Fresno, Bakersfield, San Luis Obispo, Santa Barbara, Los Angeles, Santa Ana, Riverside and San Diego. The provisional colonels are W. C. Hamatt and G. L. Dillman, of San Francisco, and C. T. Leeds, of Los Angeles. J. D. Swedberg, of Oakland, is brigade adjutant.

Lessons in Road Maintenance from New York State

By T. M. Ripley*

SYNOPSIS—These comments on road construction and maintenance are the result of a continued personal discussion between the editors and Mr. Ripley, who has had unusual opportunities to study both natural and abnormal deterioration of New York State roads. Changed conditions are described which have caused once-approved construction to become inadequate. Methods of construction and maintenance have been developed which lead to a reasonable certainty of success—provided ample funds are made available.

It is possible that the prevalence of complaints in some sections of New York State may be due to roads which are in so poor condition that they cannot be properly repaired without the expenditure of more money than is at the disposal of the Highway Department. This would be the case where the roads had been improperly built for the traffic now going over them, and where they had deteriorated so rapidly that the lighter methods of maintenance would not keep them in condition.

In dealing with this subject of road maintenance in New York, we must bear in mind that maintenance as handled today, is of comparatively recent origin, having been carried on along any definite lines, for only about three years, while many of the roads are from six to sixteen years old.

For a number of years these earlier roads were subjected to practically nothing but horse-drawn traffic, and their deterioration was comparatively slow. During the last few years this traffic has almost entirely changed. Although some of the horse-drawn traffic yet remains, the volume of the traffic is to a large degree made up of motor vehicles, ranging from motorcycles to heavy trucks, and in place of the horse-drawn vehicle, which traveled at a speed of from 3 to 8 mi. per hr., greater loads now travel at a speed of from 10 to 40 mi. per hr.

The Automobile Dominates

The advent of the high-speed automobile has further demanded a smoothness of surface that was never dreamed of with the horse-drawn vehicle, or with the slow-moving motor vehicle. The proof of this as between the horse-drawn vehicle and the motor vehicle is not necessary. For proof as between the slow-moving and the swift-moving motor vehicle, all that is necessary is to move over a piece of improved highway that is not in perfect condition, at 10 or 15 mi. per hr., or even at times as high as 20 mi. per hr., and then with the same machine move over this same road at from 35 to 40 mi. per hr. Inequalities in the road which merely give one a slight rocking sensation at the slower speed become disagreeable or dangerous bumps at the higher speeds.

To determine in the most accurate manner what is the cause of the present condition of some of these older roads would require information that could be secured only from men who are personally familiar with these roads since their completion as construction contracts. As it is practically impossible to interview these men, it is necessary to assume the conditions from our knowledge of road construction and maintenance; our knowledge of general traffic conditions as outlined; of the appropriations made by the state for maintenance in the past years; and from the fact, as before stated, that maintenance along really definite lines has been in existence for a comparatively short period. These assumptions may best be presented in a description of a hypothetical case.

Let us assume a waterbound road constructed of two courses of broken stone, the bottom course 3 or 4 in. thick and the top course 2 or 3 in. after being compacted—the road costing about $1 per sq.yd. of pavement. For the sake of our study either one of these types will answer, as these are the earlier road types. Assume that the bottom course was filled with fine material but not puddled. The top course was filled with fine material and puddled. This top-course filler was in practically all cases a selected material, and one of the objects to be secured in puddling it was to get it as nearly waterproof as possible. Such a road was opened to horse-drawn traffic. At either end of this road, which varied in length anywhere from a fraction of a mile to 7 or 8 mi., the old road conditions obtained. This hypothetical improved stretch was the best piece of road the users had ever seen outside of a city or large incorporated village, and everyone who had to use the highway of which this improved road was a part was pleased with it.

How a Good Road Became Inadequate

If a few raveled spots appeared in the road they were given little attention; the traffic and the rains many times healed these spots, as there were no swiftly moving vehicles to throw the loose stone off the road before this healing action could take place. But in some instances these spots did not heal. Nevertheless, it was a small amount of fine loose stone on a hard foundation, being gradually ground finer and finer by the traffic and offered little or no obstruction to the movement of the horse-drawn vehicles. Maintenance was scarcely thought of. The years went on. The horse-drawn traffic continued, and the wear of the road increased. In fact, whether it was a 2-in. or a 3-in. top, in many cases the surface was worn entirely off in spots, some of these spots extending quite a distance along the road. This after the passage of several years.

The automobile was then appearing as a factor, and now and then a complaint was made about the road being rough—these complaints coming not from the old slow-moving traffic, but from what we may call the new medium-speed traffic. In place of the man and his buggy, or the family and its carriage, we had a few automobiles moving, let us say, at 15 to 20 mi. per hr. and weighing a ton. While even then the auto had not become a controlling factor in our transportation problem, yet the road was obviously inadequate for the new conditions. Such a running review brings us up to about 1905.

In two or three years more the automobile had increased greatly in numbers, and it was determined that some

*Division Engineer, New York Highway Commission, Watertown, N. Y.

more positive binder must be used to hold the top course of the roads together. So in 1907 and 1908 we find bituminous material being used as a binder in the construction of a portion of the state highways, and about this time or soon after, the cry was raised that the roads were being built for the automobilist.

Three or four years more passed, and the cry became a reality. We were building roads for the automobile owner, because the automobile had become the most numerous vehicle on the highways. More and more of the new roads were being bound with bituminous material, the only binder at that time known, which would meet the conditions. The type of road had materially changed. It is still changing today. In place of the bottom or 3 or 4 in. of broken stone, we are building with 6 in. or more of larger stone, and the top is either bound with bituminous material or waterbound and bituminous application put onto the latter as soon as possible; or else a more expensive type, such as concrete or brick, is put in place of the entire stone body. The costs have jumped up to some $1.50 per sq.yd. for the bituminous carpeted road, $1.50 for the cement concrete, $2.50 for the bituminous concrete, and to $2.70 for brick[1].

The construction of a bituminous top required entirely different treatment than did the waterbound top, and engineers and contractors were both ignorant as to the methods required. It took several years to learn the most essential points in the construction of a maintenance top, in order that the road might be smooth when completed—and even today this desirable condition is not always obtained.

Maintenance Question Arises

The maintenance of the roads constructed prior to 1908 and those in the years immediately following was left almost entirely to patrolmen who were appointed because of the political ticket that they voted. The energies of the Highway Department were devoted almost exclusively to the construction of new roads and an effort so to build them that the traffic conditions could be met and criticism stilled. Looking back from the present, it seems almost certain that the engineers of six and eight years ago did not conceive what would be the traffic conditions of today, or else conditions which they could not control prevented doing the work that they desired. From year to year, as the maintenance question was brought more forcibly to the attention of the people, it was passed by in the belief that it would be met providentially in some manner or other; the department lived from year to year, with the ever-present hope that enough money would be appropriated to put the roads in proper condition, although each year without proper maintenance made the situation more nearly impossible.

No one, excepting a person familiar with the situation, realized that these older roads, numbering about six hundred, besides many of the later ones, would have to be practically rebuilt so far as their metal was concerned, or entirely resurfaced in order to give the highway demanded by the automobile of later date.

Therefore, in regard to the "earlier roads," with which it seems conservative to place those built prior to 1910 or 1911, their present condition in the majority of cases can be attributed to improper design for the present traffic, to lack of knowledge of the necessity for maintenance, and finally to a lack of money to cover that necessity provided it had been recognized.

Aside from the earlier roads mentioned, there have been many hundreds of contracts, aggregating two thousand miles or more of improved highways, which can go into what might be called "later construction"—and "construction" as here used means both the design and the physical action of building the road.

Maintenance and Recent Construction

In regard to the maintenance of these later roads, their present poor condition is due first to the fact that it had not been clearly recognized that maintenance must start as soon as the road is opened for traffic, and that *some definite surface treatment must be given to a macadam road, whether waterbound or bituminous, not later than two years from the date of its completion,* if this road is to be kept in good condition.

Secondly, in the earlier part of this latter stage the men in charge of construction had nothing whatever to do with the maintenance, and it was looked upon as a side issue. Although it was handled by the general department, nevertheless few of the men cared to be associated with it. The roads were scattered over the entire state, some of them in almost inaccessible places, and the man in charge of a district had an extremely large territory. He was appointed because of his political friends, and to take a day's journey to look at four or five miles of country road could readily be construed as a waste of energy.

Although it was reported that other states had smooth and beautiful roads, nevertheless it was not considered of enough value to the state to pay the expenses of its employees to go and examine these roads, and for the first few years the work of maintenance seems to have drifted along without any definite port in view or any rudder to guide it. This condition has been entirely changed within the last two or three years.

Today the maintenance is under the same corps of men as is the construction, and the same men in the field are held responsible for the maintenance of their roads as for the building of the new ones. Fairly definite ideas have been formed as to the treatment of different types of roads, and efforts are made by the department to secure the money necessary to carry out these ideas. There is probably no executive officer in the department today, who has authority over the field work, but who knows practically what these definite ideas are, even to the men in imme-

[1] Two hundred and forty-two waterbound roads built between 1898 and 1908 of two 3-in. courses of broken stone cost per square yard of pavement $1.05, or per square yard of roadway $0.63; 61 waterbound roads built between 1910 and 1915 with 6 in. of foundation stone and 3 in. of top stone cost per square yard of pavement $1.29, or per square yard of roadway $0.76; 126 bituminous state highways built between 1911 and 1915 cost per square yard of pavement $1.42, or per square yard of roadway $0.81; 130 bituminous county highways built between 1911 and 1915 cost per square yard of pavement $1.48, or per square yard of roadway $0.79. The average cost of brick roads built prior to 1915 was $2.67 per sq.yd. of pavement, or $1.48 per sq.yd. of roadway. The cost of concrete roads prior to 1915 was $1.40 per sq.yd. of pavement, or $0.72 per sq.yd. of roadway. The average cost of bitulithic roads prior to this date (1915) was $2.42 per sq.yd. of pavement, or $2.26 per sq.yd. of roadway. In all of the preceding figures the total cost of the road has been divided by the square yards of pavement actually laid for the first cost shown and divided by the total square yards in the highway between the ditch lines for the second cost, the distance between ditches being taken at a theoretical elevation, as shown on the standard plans. The two costs given for bitulithic are more nearly alike than the similar two costs for any other pavement; this is because a very small portion of bitulithic was built outside of city or village streets, where the entire width of the roadway was paved. The foregoing costs show an increase during the last few years of construction. This is due primarily to the heavier roads that were constructed in this latter period.

diate charge in the field. Moreover, these field men have had from one to three years' experience and there is no excuse, except the lack of funds, why the roads should not be in condition to carry the present automobile traffic.

From the reasons immediately before stated, *it is a fact that the question of successful maintenance today rests upon the money available and the willingness of the men to work* more than upon any physical characteristic of the roads.

Organization of Maintenance

The physical maintenance can be divided roughly into two classes—heavy and light. Heavy maintenance is that work which requires a more or less complex organization and plant and would include the reconstruction and resurfacing of roads, the widening of the macadam, etc. This heavier maintenance costs from $3,000 to $6,000 per mi. and results in constructing a new wearing surface for the road, besides strengthening weak places by putting in new foundation, etc. The report of Fred W. Sarr, Second Deputy Highway Commissioner to the Hon. Edwin Duffey, Commissioner, dated Jan. 1, 1916, states that during the year 1915 the average cost of resurfacing and reconstruction on about 5% of the total mileage of improved highways was $5,500 per mi., which, figured on the basis of a 16-ft. bituminous-macadam road, would be equal to about 60c. per sq.yd.

The lighter work consists of patching, cleaning the ditches and shoulders and applying the lighter asphalt compounds. This work takes a much less complex organization, both of men and machinery. Moreover, this latter class of maintenance can be done, and is usually done, while traffic is going over the road, while the former maintenance practically requires the closing of the road. The cost of this lighter maintenance is divided between the patrol as now organized, maintenance gangs, and contract or day labor for putting on the light asphalt.

The heavier class of maintenance can probably better be done by contract, but the lighter class can better be done by departmental forces. Much of it is and always has been so done, particularly the cleaning of the shoulders and ditches and the minor patching, which is taken care of by the patrolmen. In the last few years the patrol situation has greatly improved, as the patrolmen have been put under the division offices and have been given to understand that their position depends upon the quality of their work as well as upon their politics.

Owing to the increase in the mileage of bituminous roads during the last few years and to the further fact that it has been demonstrated that an application of light bituminous material applied about every two years was the most efficacious maintenance therefor, there has developed a practically new line of work commonly known as "cold oiling." This is a simple operation requiring no organization that cannot be procured in the neighborhood, and a comparatively simple plant layout.

The time at which this application is made is important not only for the best interests of the physical road, but also for the traveling public. Moreover, in a great majority of cases a road does not need an equal application over its entire length, and therefore the application should be frequently varied. These two elements of time and variable quantity of material applied, coupled with the simplicity of the operation, make it a class of maintenance that can best be handled by the department.

The cost of "cold oiling," like the cost of the heavier class of maintenance before mentioned, varies between quite wide limits, owing to the many factors that enter therein. With local covering material handy and easy to obtain, this work can be done as low as 3c. per sq. yd. On the other hand, where the cover for the bituminous material, or cold oil, has to be shipped long distances by rail or some other items are expensive, the cost can easily become 5c. per sq.yd.

Owing to numerous legal complications, as well as other causes, light maintenance by the department has not been developed as economy would warrant. Such expansion would entail close and detailed application on the part of much of the organization, and the development of an executive ability which, along certain lines, is now practically dormant under the contract system.

Effect of Weather

The deterioration not due to wear, as well as the wear of the traffic itself upon the road, is prevented and compensated for in a very large measure, on macadam roads, both waterbound and bituminous, by the application of the light bituminous material noted, particularly as on all of these applications there is spread a thin wearing or blotter course of sand, fine, clean stone, gravel, iron-ore tailings, or some similar material, which takes the first wear of the traffic.

It is believed that the physical factors that cause deterioration (aside from normal wear) are principally frost and the deterioration of the bituminous binder. In some portions of the state the frost action at times is extremely severe, particularly upon roads that have not proper subdrainage. Roads have been "blown up" by frost to such an extent that had a rooter plough gone through them, they could not have been in much worse condition. Such effects as these can be remedied only by practical reconstruction.

The deterioration due to the reduction in the binding quality of the bituminous material can, in a large measure, be offset by the lighter application above mentioned.

Interurban Motor Busses

There is another factor that is becoming more and more persistent, which in the natural progress of events shortly may be included in normal wear, but which has in the past been considered to give abnormal deterioration. This is the operation of motor-vehicle lines for hire between villages and cities, running upon a schedule. These vehicles operate at all seasons of the year when they are able to traverse the road. Although the ordinary automobile traffic is heaviest in the summer and fall, when the roads are in the best condition to support it, this auto-vehicle traffic operates when the roads are soft from frost in the spring and when they are alternately freezing and thawing in the fall. In many portions of the state they are a serious menace to the integrity of the improved highways.

There are other abnormal conditions which are only local in effect and which scarcely need be considered here, such as particular factory districts and mining districts. Such districts as these, from the engineering side, demand special treatment in design, but frequently this is impossible owing to the fact that many other interests besides those of the engineer have the ability to control the design, through the power to regulate the money available.

Roads are being extensively constructed and successfully maintained over which automobiles can be operated with comfort and safety at the higher rates of speed earlier referred to. So to construct these roads means giving them a better wearing surface than was contemplated 15 years ago; more diligent and careful maintenance is essential. I have in mind a stretch of road 150 mi. long, over which we went into many different counties, driving with perfect ease and safety at an average speed of 30 mi. per hr. The condition of this road is due to the fact that the men in charge are constantly watching it and doing what their funds will permit to keep it in proper repair.

It may be well to say something here in regard to the man who knows how to drive. This is the man who understands his machine and obeys the law. He is the man who can, in the country where the road is clear and smooth, and with a so-called high-power car, make the hills at the same speed that he travels upon the level; he slows down for the villages and doubtful traffic; he takes advantage of the good road and saves his machine on the bad road. Existence of such a class of drivers is not a theory but a fact; I have seen men who would travel the distance noted at the speed indicated, and yet at no time with the clearest and best road in the country did they exceed 35 to 37 mi. per hr., cutting their speed down as low as 15 and 20 mi. per hr. in the villages. Such a driver with a clear road will travel at from 30 to 33 mi. per hr. up hill and down for hours at a time, where one who does not understand his machine thoroughly will be operating it at better than 40 mi. per hr. to make the same average speed. It is these higher rates of speed which demand the smoother road and which cause many of the criticisms that come. It is these extreme rates of speed which require the better-bound roads.

Methods of Stream Gaging

By W. S. Pardoe*

There are a few points regarding approximate methods of stream gaging which are not at present presented with any degree of clarity in textbooks devoted to this subject.

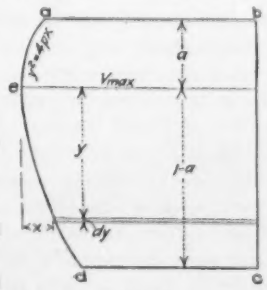
If a large number of velocity measurements be made at varying depths in a stream and these velocities plotted, the resulting curve can be closely approximated by a parabola with axis horizontal at the point of highest velocity, varying values of the parameter (*latus rectum*) being used to give the correct curvature. The following discussion depends on this fact.

The area inclosed by *abcde* is proportional to the discharge in a section

$$dA = \left[V_{max} - \frac{y^2}{4P}\right] dy$$

$$A = \left[V_{max}\, y - \frac{y^3}{3(4P)}\right]_{-(1-a)}^{a}$$

$$= V_{max} - \frac{1 - 3a + 3a^2}{3\,(4P)}$$



This is also equal to the mean velocity, as bc = unity.

Let y_1, y_2 and y_3 be the depth of measurements made in approximate methods:

1. One-Point Method—0.6 depth.

$$V_{max} - \frac{(y_1 - a)^2}{4P} = V_{max} - \frac{1 - 3a + 3a^2}{3\,(4P)}$$

or

$$y_1^2 - 2y_1 a + a - \tfrac{1}{3} = 0$$

It is evident that the only value of y which will satisfy this equation is

$$y_1 = a + \sqrt{a^2 - a + \tfrac{1}{3}}$$

As a varies from zero to 0.5, it is evident that the one-point method gives only very approximate results.

2. Two-Point Method—0.2 and 0.8 depth.

$$\frac{V_{max} - \frac{(a - y_1)^2}{4P} + V_{max} - \frac{(y_2 - a)^2}{4P}}{2}$$

$$= V_{max} - \frac{1 - 3a + 3a^2}{3\,(4P)}$$

or

$$\tfrac{2}{3} - 2a + 2a\,(y_1 + y_2) - y_1^2 - y_2^2 = 0$$

$y_1 = 0.2$ and $y_2 = 0.8$ very nearly satisfy this equation and eliminate the effect of variations in a, which is most desirable; $y_1 = 0.21$ and $y_2 = 0.79$ will give slightly more accurate results.

3. Three-Point Method—0.2, 0.6 and 0.8 depth.

$$\frac{3V_{max} - \frac{(a - y_1)^2}{4P} - \frac{(y_2 - a)^2}{4P} - \frac{(y_3 - a)^2}{4P}}{3}$$

$$= V_{max} - \frac{1 - 3a + 3a^2}{3\,(4P)}$$

or

$$1 - 3a + 2a\,(y_1 + y_2 + y_3) - y_1^2 - y_2^2 - y_3^2 = 0$$

It is evident that $y_1 = 0.2$, $y_2 = 0.6$ and $y_3 = 0.8$ do not satisfy this equation and do not eliminate the effect of variation in a; $y_1 = 0.15$, $y_2 = 0.5$ and $y_3 = 0.85$ eliminate a and satisfy the equation.

The points I have tried to bring out are: (1) The one-point method (0.6 depth) is only very approximate, but will be correct for $a = 0.15$. (2) The two-point method (0.2 and 0.8 depth) is very nearly theoretically correct and gives correct results (see table in Hoyt and Grover); also that 0.21 and 0.79 depth would be a little more nearly correct. (3) The three-point method (0.2, 0.6 and 0.8 depth) is not as accurate as the two-point method, which is corroborated by the previously mentioned table. If the three-point method is to be used, I would suggest 0.15, 0.5 and 0.85 depth. (4) If the mean of *(n)* points is to equal the mean velocity in a vertical, the points should be selected to eliminate *(a)* and satisfy the following equation

$$\frac{n}{3} - na + 2a\,(y_1 + y_2 + y_3 + \text{—} y_n) - y_1^2 - y_2^2 - y_3^2 - y_n^2 = 0$$

*Assistant Professor in Municipal Engineering, University of Pennsylvania, Philadelphia.

Heating Standard for Gas—The Public Service Commission for the First District, State of New York, is about to establish stations in all boroughs of the city for the purpose of testing the heating value of gas supplied by the gas companies in this district. The law at present requires the testing of gas as to its illuminating power only. While the law requires a standard of 22 cp. for gas supplied in the first district, the value of such a standard is questioned at the present time, when comparatively few open-flame burners are used, when mantle lamps are extensively employed and when gas is used largely for heating, cooking and power purposes.

[1]This equation is put in somewhat different form in "River Discharge," by Hoyt and Grover.

Memphis Flood Protection

SYNOPSIS—Rising flood levels in the Mississippi River made necessary the protection from inundation of a low-lying tract in the City of Memphis. A levee with concrete core wall has been built in front of this tract, and a pumping station lifts the water draining from the territory back of the levee when the river is in flood. Water draining from higher elevations, which would otherwise flow to the pumping station, is intercepted and discharged to the river through two large tunnels driven through soft ground with considerable difficulty.

The City of Memphis, Tenn., has nearly completed extensive works to make the city secure against damage by high water in the Mississippi River. During the Mississippi floods of 1912 and 1913 the newspaper reports gave the impression that a large part of the city was inundated by the high water in the Mississippi. Fortunately for Memphis, this was not the case. Most of the city stands on the high bluffs that bound the Mississippi on the west and are at an elevation of 150 to 200 ft. above low-water mark in the river.

Prior to the year 1900 no flood in the Mississippi ever caused any damage in Memphis. About that time, however, the extension of the levees protecting the St. Francis basin on the west bank of the Mississippi prevented the flood waters of that stream from overflowing an area of land some 50 mi. wide to the west of the river, and it became evident that flood levels in Memphis were to be much higher in the future than in the past.

In 1903 the Mississippi at Memphis reached a stage of 40 ft. above low water, and some lands in the northern part of the city lying along the banks of the Bayou Gayoso were flooded. This bayou is a small dry creek that rises in the southern part of the city and discharges near its northern boundary. In order to protect the property along the lower regions of the bayou from being overflowed, levees were built along the lower course of the stream at an elevation to withstand the backwater from a flood of 41 ft. in the Mississippi.

This system gave satisfactory protection until 1912, when at the time of the floods which devastated Ohio the Ohio River rose to an unprecedented stage and it became evident that all previous flood heights at Memphis would be exceeded. Rush work was begun, raising the levees along Bayou Gayoso and they successfully held the water until a stage of 42 ft. was reached, when they broke and the land back of them was overflowed. The Mississippi rose to a stage of 45½ ft. and would have gone to 48 ft. at least, had not the levees protecting the Arkansas bottom lands on the west side of the river broken and allowed the flood waters to discharge there.

It was seen that to protect the flooded area from future damage a different plan would have to be adopted. While some urged that the conditions in 1912 were unprecedented and need never be expected again, action was hastened by a recurrence of the flood in 1913, when the river reached a stage of 46½ ft. It was determined, after careful consideration, that in order to make the low-lying lands in North Memphis safe against overflow, a flood of 50-ft. stage in the Mississippi must be guarded against.

The Board of Commissioners of Memphis instructed the City Engineer, J. H. Weatherford, to prepare plans for flood protection.

Three different plans were studied. The first plan proposed the raising of all streets in the flooded area to an elevation that would bring them above a 50-ft flood. The second plan was for the building of a complete system of storm sewers throughout the entire city, with pumps to discharge the storm water falling below the 50-ft. contour during seasons of high flood. Both these plans were found to involve a cost greater than was justified. The plan finally adopted may be readily understood by examination of the accompanying sketch map (Fig. 1). It involves, first, a levee along the river front near the outlet of Bayou Gayoso, protecting the land along its lower course from overflow by back water; second, the diversion of the flow in the upper reaches of the bayou into the river by gravity; and, third, at the mouth of the bayou a pumping station capable of discharging the remaining flow in that stream into the river in time of flood, as well as the sanitary sewage and storm water from the low-lying section.

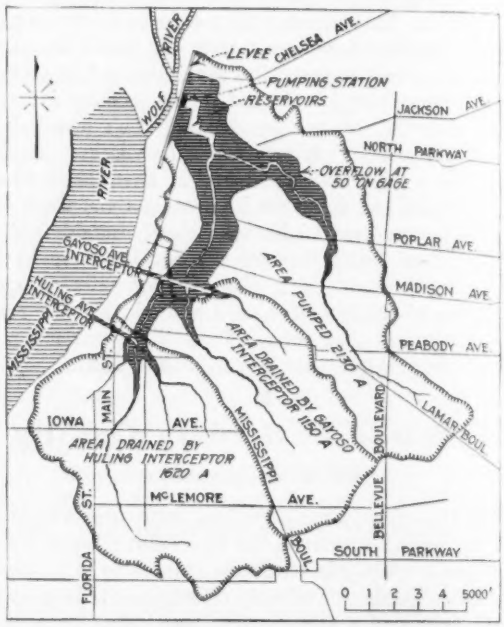


FIG. 1. SKETCH MAP OF FLOOD-PROTECTION SYSTEM, MEMPHIS, TENN.

A levee about 6,000 ft. long was built along the river front to prevent backwater from the river entering the valley of Bayou Gayoso. The levee has a minimum top width of 40 ft. with side slopes of 3 on 1. For a considerable distance it was necessary to avoid the land damage resulting from the slope of the levee on the land side. Here a concrete retaining wall with vertical face was built for a distance of 2,380 lin.ft. This wall has a face 10 to 12 in. thick, is 14 to 26 ft. in height and is held erect by tension counterforts 12 in. thick. The crest of the levee was placed at an elevation of 52.5 ft.

The site of the levee was covered with a deposit 3 to 15 ft. deep of cinders, bark and slabs. Under this were

strata of river silt, quicksand, clay, etc., as shown on the accompanying section (Fig. 2). A line of 35-lb. United States steel sheet piling was driven through the soft material into a hard blue clay at a depth of 35 to 50 ft. The piles were driven with a 2,500-lb. drop hammer. Concrete walls were built on top of these steel sheet piles; and where the core wall was built inside the earth levee, an extra-long steel pile was left every 9 ft., extending up above the other piles to a height of 46 ft. on the gage, or 6 ft. below the top of the levee; 540 ft. of core wall of this type was constructed. The steel piling cost $29.84 per ton, and the cost of hauling and driving was 9.9c. per sq.ft.

The city furnished and drove the sheet piling, did the stripping and built the concrete walls. The earth filling in the levee, amounting to about 200,000 cu.yd., was done by the Illinois Central R.R., which will occupy the top of the levee with its tracks.

The Pumping Station

The entire drainage area of Bayou Gayoso is 4,900 acres, but 2,770 acres in the upper part of this area was drained by gravity to the river through two intercepting tunnels as shown in Fig. 1. This left an area of 2,130 acres tributary to the pumping station. It should be understood, however, that it is only necessary to pump the flow from this area during periods of high flood. At all ordinary times the flow of the bayou will discharge into the river by gravity. Further, to reduce the time during which pumping will be necessary, the old levees along the bayou were retained, so that it is not necessary to begin pumping until a stage of 40 ft. is reached in the river. This also reduces the pumping lift, since it is not necessary to lower the level of the water in the bayou below 35 ft.

From a careful study of rainfall records it was determined to fix the maximum runoff on the area drained at 4,160 cu.ft. per sec., equivalent to a discharge at a rate of 2 in. of rainfall per hour all appearing as runoff. The chance is so small, however, that such a period of maximum rainfall will coincide with a period of maximum flood that it was deemed sufficient to take the rainfall at 1½ in., or a runoff of 3,120 cu.ft. per sec. To reduce still further the necessary capacity of the pumping station, certain areas of low-lying land of little value along the valley of the bayou were purchased for use as storage reservoirs. By storing the peak of the flood in these reservoirs the pumping station does not need to be of so large capacity. It was finally designed for 1,200 cu.ft. per sec.

Besides the water flowing down the bayou, it was necessary to drain the lowland behind the bayou levees. A storm sewer was built through this territory, discharging at the pumping station. A large part of the city's sanitary sewage is discharged into the river at this location through a 48-in. main sewer. Water begins to back up in this main sewer when the river gage reaches 34 ft. To provide for this situation, a bypass has been constructed where this main sewer intersects the storm

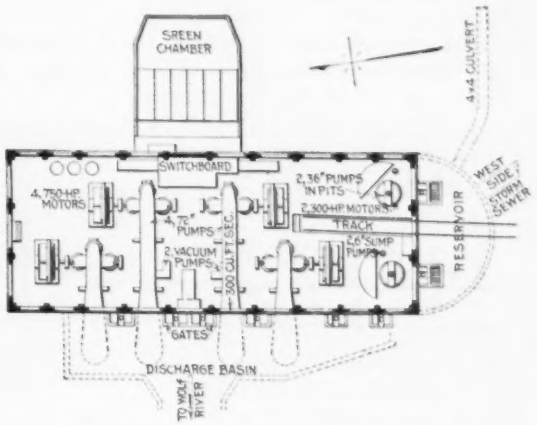


FIG. 3. PLAN OF PUMPING STATION

sewer previously referred to, so that the sanitary sewer may be discharged into the storm sewer at times of flood, backflow from the river being prevented by flood gates in the sanitary sewer. The discharge through this storm sewer, which has to be taken care of at all times of high water or for a period of two months more or less in the average year, is handled by separate low-level pumps in the drainage pumping station, with a capacity of 160 cu.ft. per sec.

The pumping station is founded on 1,200 creosoted yellow-pine piles driven through the soft material to the hard blue clay below. On the heads of these piles rests a concrete floor 3½ ft. thick, with its top surface 6½ ft. above low-water mark (Fig. 4). This floor carries the pumping machinery and the walls of the building. The west wall, which forms a part of the levee, is 5 ft. thick at the base, reducing to 2 ft. thick at 52 ft. elevation. Under this wall, as under other parts of the concrete levee wall, interlocking steel sheet piling was driven through the soft material to the impervious blue clay below. This concrete wall is pierced by four openings 7½x10 ft., controlled by rectangular sluice gates. These gates are closed only during flood periods in the river; at all other times they are open to permit the water in the bayou to flow into the river by gravity.

At an elevation of 36 ft. above the foundation floor is a reinforced-concrete floor of the beam and girder type, supporting the machinery. This floor is carried by concrete columns from the foundation floor, and these columns are braced near the middle of their height by concrete struts. The building is 60x 160 ft. long, and its outside walls are of concrete to an elevation of 52. Above this, concrete pilasters are carried up to support the crane girders, with curtain walls of red brick between. Steel trusses support the roof, which is of 3-in. concrete-slab construction reinforced with ⅜-in. rods spaced 6 in. apart, with longitudinal rods spaced 24 in. apart, the concrete being

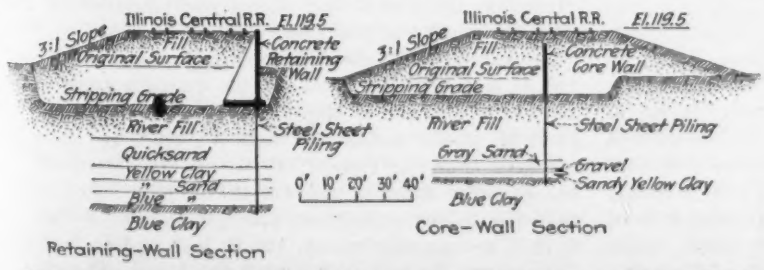


FIG. 2. SECTIONS OF LEVEE ALONG RIVER FRONT AT NORTH MEMPHIS

covered with Carey composition roofing. The foundation concrete was mixed with river run sand and gravel as aggregate, five sacks of cement being used to 1 cu.yd. The reinforced concrete in the superstructure was made with crushed limestone as the aggregate, six sacks of cement to ½ yd. of sand and 1 yd. of crushed stone (1 : 2½ : 5).

The main pumping plant, which is of 1,200 cu.ft. per sec. capacity, is operated when the river is at stages of 40 ft. or higher and when the flow in the bayou is such as to require its operation. The low-level pumping plant, which is of 160 cu.ft. capacity, is operated when the river is at 34 ft. or higher. The head against the pumps varies of course with the stage of water in the river. The main plant is designed for a maximum head of 15 ft., the low-level plant for a maximum head of 25 ft.

The main pumping plant consists of four 72-in. centrifugal pumps mounted on horizontal shafts and each driven by a direct-connected 750-hp. 3-phase 50-cycle, 6,250-volt slip-ring induction motor, with a normal speed of 116 r.p.m. The pumps are set on the machinery floor, high above the normal water level. To put them in operation the motor is started under no load, the pump runner revolving in air. When the pump is running at speed, vacuum pumps are started, which exhaust air from the pump chamber and as it fills with water, the pump begins operation. To prime the pumps in this way there is a battery of two Connersville rotary vacuum pumps of 400 cu.ft. per min. free-air capacity. Each pump is connected by a silent-chain drive to a 20-hp. electric motor.

There are no valves whatever on the pipes leading to and from the pump. It will be evident, therefore, that the pump chamber acts as a siphon. In case of failure of the current and stoppage of the pump at a time when it is lifting water into the river there would be a prompt reversal of the flow through the pump, and a huge stream would be discharged back into the bayou under a head due to the difference in the level of the water inside and outside. To prevent this reversal of flow, the pump is provided with an automatic vacuum breaker. As soon as the current supplied to the motor is cut off, either purposely or by accident, a 6-in. valve is automatically opened, permitting air to flow back into the top of the pump chamber, so that the back flow of water through the siphon will be prevented before the pump has actually ceased to turn.

At the south end of the building is a circular pump well 20 ft. in diameter containing two 36-in. vertical-shaft centrifugal pumps of 80 cu.ft. per sec. capacity, each driven by a 300-hp. 6,150-volt induction motor at 165 r.p.m. As already explained, these pumps handle the flow of sanitary sewage and the storm-sewer discharge from the low district and greatly reduce the time during which it is necessary to operate the large pumps.

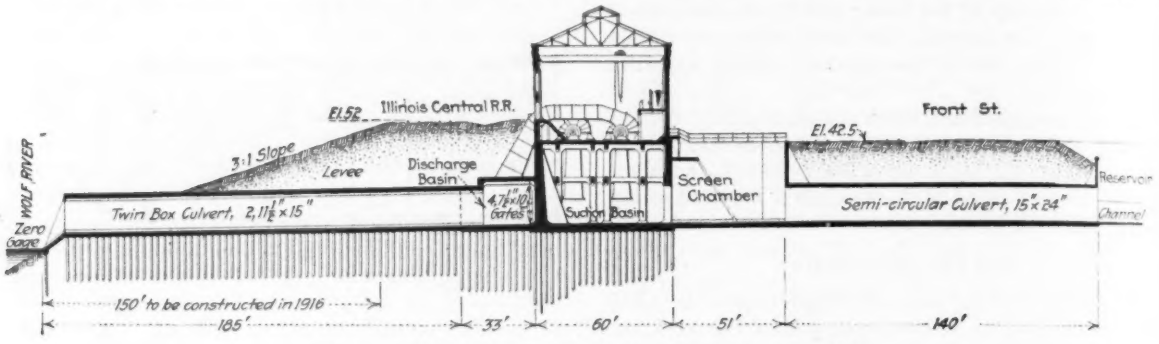


FIG. 4. CROSS-SECTION THROUGH PUMPING STATION

To protect the pumps from obstruction a screen chamber 40 ft. wide is located on the east side of the building, in which is placed an inclined rack 30 ft. high and 40 ft. wide. Suitable screens also protect the low-level centrifugal pumps.

Power for operating the pumps is supplied by the Memphis Consolidated Gas and Electric Co. by a special contract, under which it agrees to keep sufficient reserve power available for operation of the station at all times. A duplicate transmission line from the power station to the pumping station, about 3 mi. long, has been installed, of which 2½ mi. is underground. The pumping station was erected by the James Alexander Construction Co., Memphis; the pumps and motors were installed by the Allis-Chalmers Manufacturing Co.

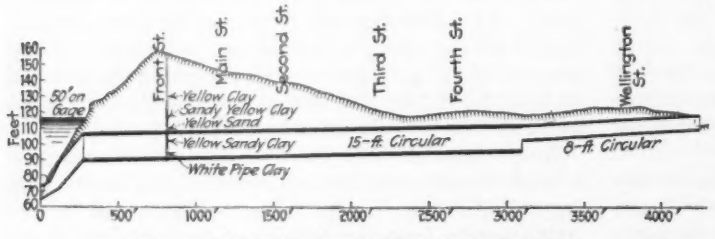


FIG. 5. PROFILE OF GAYOSO AVE. TUNNEL

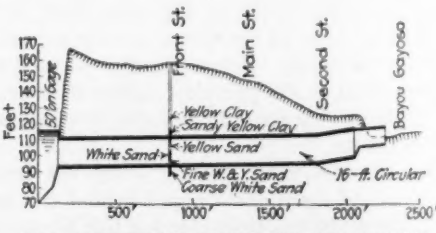


FIG. 6. PROFILE OF HULING AVE. TUNNEL

As shown on the sketch map, Fig. 1, the Huling Ave. tunnel is designed to intercept the drainage from 1,620 acres near the head of Gayoso Bayou. The tunnel (Fig. 6) is of circular section, 16 ft. in diameter, and extends eastward from the river 1,925 ft. At the river end it has an outlet apron or spillway 125 ft. long. The 16-ft. tunnel is fed by an 8-ft. circular branch 830 ft. long, a 9x10-ft. rectangular branch, 125 ft. long and an 8x14-ft. rectangular channel about 2,900 ft. long. The 16-ft.

circular sewer is lined with monolithic concrete 22 in. thick, the lower one-third of the section being faced with vitrified brick, to stand erosion. About 1,700 ft. of this structure was built in tunnel and the remainder in open cut.

The tunneling work was especially noteworthy because of the difficulties encountered. For a considerable distance the depth of cover over the tunnel is about 55 ft.

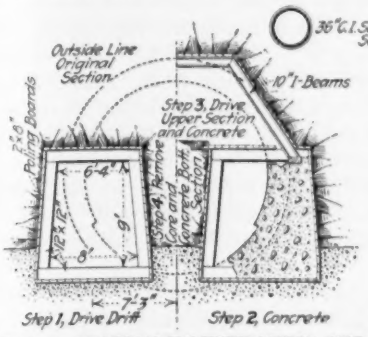


FIG. 7. SECTION ILLUSTRATING SECOND METHOD OF OPERATION IN DRIVING HULING AVE. TUNNEL

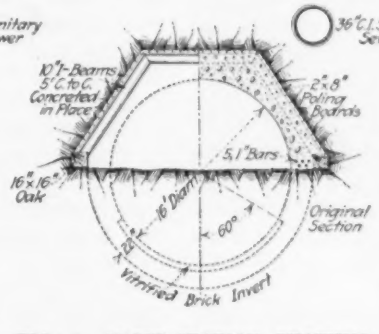


FIG. 8. CROSS-SECTION SHOWING THIRD METHOD OF DRIVING HULING AVE. TUNNEL

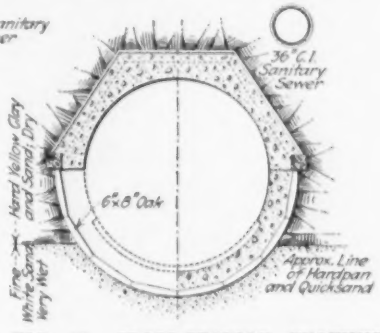


FIG. 10. CROSS-SECTION SHOWING METHOD OF COMPLETING LINING OF HULING AVE. TUNNEL

The tunnel was directly under the line of the street above. On account of the buildings along the street it was necessary to use great care not to cause settlement in the work of excavation. Work was started at the river end with a circular steel shield 21 ft. in diameter and 9 ft. long, driven forward by 16 hydraulic jacks. The original plan was to line the tunnel with oak segments 4 ft. long, 6x8 in. in section, for the jacks to push against. Inside this wooden lining the concrete lining was to be placed according to the general method carried out in the Dorchester tunnel under Fort Point channel, Boston, described in *Engineering News* of Jan. 20, 1916.

The shield was built at a local boiler shop and weighed complete about 16 tons. Its skin was made up of ⅝-in. plates with lap joints and the three successive rings of plates were joined by telescopic joints, so that the diameter of the shield at the cutting edge was about 2½ in. greater than the diameter at the tail. Inside the cylinder thus formed were placed eighteen 6-in. I-beams running longitudinally and bolted to the skin of the shield. These I-beams were 3 ft. long and were placed 18 in. back of the cutting edge of the shield with their rear ends 5 ft. in front of the tail. A 4x4x⅜-in. angle bent to a circle was riveted to the skin at the front and rear of these longitudinal beams, and the 18 jacks used to shove the shield bore against the rear angle. A pair of 12-in. channels riveted together back to back was bent to circular form and placed inside the longitudinal beams, and there were two working platforms. There was no other interior bracing and it will be seen from the above that for 18 in. back from the cutting edge and for 5 ft. in front of the tail there was no bracing whatever for the skin of the shield.

This shield was forced forward by 18 hydraulic jacks of 5 in. diameter, supposed to operate under 3,000 to 5,000 lb. pressure; but when the movement of the shield was too slow, the safety valve and automatic stop on the hydraulic pumps were removed and the pressure raised to 8,000 lb. per sq.in.

After the shield had been driven forward about 75 ft. the overload from the jacks and the pressure of the superincumbent earth, about 50 ft. in depth, so distorted the shield that work was stopped. The top of the shield was bent in about a foot, and the working platforms were crumpled up.

Plans for repairing and reinforcing the shield were made by C. H. Hollingsworth, superintendent for the contractors, and some six weeks were spent in this work. In order to do this it was necessary to excavate the material overlying the shield, and timber around the shield so that it was entirely exposed. In rebuilding, only the skin of the old shield was used. In this was placed an entirely new system of interior bracing containing 46,000 lb. of steel.

Experience proved, however, that it would have been better to have replaced the outer skin as well, for when the rebuilt shield was again started the ⅝-in. shell plates showed a tendency to bend and buckle on striking the slightest obstruction. The shield was forced forward, however, until 560 ft. of tunnel had been completed. The shield then failed so completely that it was decided to abandon this method of tunneling entirely.

The contractor then attempted to drive the tunnel forward by the method illustrated in Fig. 7. Two rectangular drifts 10x11 ft. in size were driven forward on each side, leaving the material between and above them undisturbed. Inside these drifts concrete was placed for the haunches of the arch. Then a top drift was carried forward large enough to include the upper half of the arch ring, the timbering supporting this drift footing on the concrete already placed. Inside this drift the upper half of the lining was built, and to complete the tunnel the core of earth at the bottom was removed and the invert was closed.

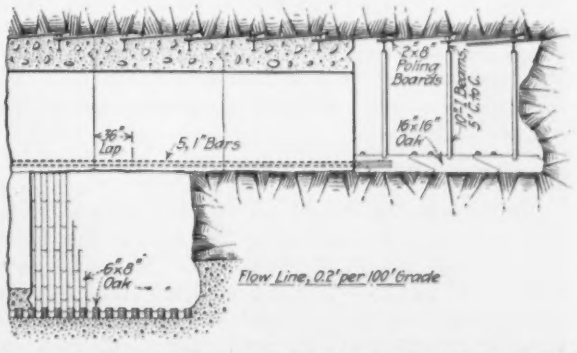


FIG. 9. LONGITUDINAL SECTION ILLUSTRATING THIRD METHOD OF DRIVING HULING AVE. TUNNEL

This method was enormously expensive for the contractor, since he was placing double the quantity of concrete he received pay for and was removing a considerable excess of earth for which he received no compensation. In addition to this the methods used left voids at the junction of the side drifts and the top drifts and the leakage of air was so great that it proved impossible to hold sufficient air pressure to keep back the water in the lower sand strata. These difficulties increased so rapidly that the contractor was again shut down after making only 385 ft. additional and required to submit still another method.

Final Method on Huling Ave. Tunnel

The new method, which may be termed a flying arch method, was authorized since the arch could be built entirely in a hard sandy clay strata entirely above the water-bearing sand. It seemed probable, also, that air pressure could be dispensed with, but this was not done, the work being carried on under from 5 to 10 lb. of air.

The method used was to drive a top drift with poling boards supported by 10 in. standard I-beams 5 ft. centers as in the previous section, the beams ordered for that work being used; these beams resting on 16x16-in. oak blocks having a net length of 5 ft. as shown in Figs. 8, 9 and 10. After drifting about 50 ft. ahead, a section of form was placed and the arch concreted; five 1-in. reinforcing rods were placed as shown at the external lower edge of the side walls.

The top drift was driven and concreted the remaining 730 ft. before any further work was done on the bottom. On completion of the arch a section about 15 ft. long immediately adjoining the end of the completed invert was excavated and lined with the oak cants, which had been purchased for use with the shield, the water being held back by the air pressure. Ten feet of this section was then lined with concrete and 10 ft. additional was then excavated, and lined and so on.

All this tunneling work was done under compressed air at 5 to 9 lb. pressure. The voids back of the lining were filled with grout, and so thoroughly was the grouting done that in some cases the grout was forced upward until it appeared on the street surface. The contractor for this work was the Southern Asphalt and Construction Co. The contract price, which included the portion built in open cut, was $230,000.

The Gayoso Ave. Tunnel

The Gayoso Ave. tunnel drains 1,150 acres below the area intercepted by the Huling Ave. outlet. The tunnel (Fig. 5) has 275 ft. of outlet section of special form, 2,805 ft. of 15-ft. circular section, 1,155 ft. of 8-ft. circular section, an 11½-ft. section 420 ft. long and a 6-ft. rectangular branch 570 ft. long. The whole work was built by Thomas-Hammond & Hickey Brothers Co., the contract price being $218,000. The 15-ft. tunnel is lined with monolithic concrete 20 in. thick, where built in tunnel, and reinforced-concrete 12 in. thick in open cuts.

The circular tunnel section was lined with 20 in. of concrete and was built by the shield method, using wood lagging or cants. The shield was 19 ft. 10 in. outside and 9 ft. long—the outer shield being of ¾-in. plates, stiffened by two ¾-in. annular plate ribs and angle irons and had an interior cylindrical lining about 16 ft. in diameter and 4½ ft. long leaving a 36-in. tail shield and and 18-in. cutting edge. There was one horizontal platform on the center line of the shield. This shield was forced forward by 16 Watson-Stillman hydraulic jacks 7½-in. diameter and 24-in. stroke under about 4,000 to 5,000 lb. water pressure. The jacks pushed against the lining of 6x4-in. cants about 4 ft. long with their outer surface cut to a 9 ft. 10 in. radius. The cants were placed from the bottom upward; the two cants at the top were set by placing one end of each against the other cants of the ring with the other ends together and forcing these ends back with a jack. The cants were laid to break joints and were ordinarily spiked to the next ring back to hold them, but were so firmly interlocked by the pressure against them as to render them extremely rigid when in place. The cants compressed under pressure about 10%, 10 ft. of wood making approximately 9 ft. of lining. Pine, gum and oak were used in the order named, the pine failing utterly and the gum being abandoned in favor of the oak.

Occasional trouble was had from the lining breaking under the jack pressure, making it very hard to keep the shield on line and grade; but after placing, no settlement could be detected by measurement of the sides or roof, though the shield was at one time 200 ft. in advance of the concrete lining.

Excavation was pushed continuously with three 8-hr. shifts, being discontinued ordinarily only during concreting. Progress averaged about 5 ft. for each 8-hr. shift, and including all delays averaged 10 ft. per day.

The material encountered was a hard clay varying to a hard, sandy clay for the top two-thirds and a fine, water-bearing sand for the lower one-third. Practically the entire length of tunnel was built under air pressure of 5 to 10 lb. All excavation and materials, except concrete, were hauled with one electric locomotive, using current from overhead trolley, and were locked into and out of the tunnel. A single track line with turnouts was used.

Mixing and Placing Concrete

The concrete in both these tunnels and in the connecting works was made of river run sand and gravel dredged from the Mississippi, five sacks of cement being used to 1 cu.yd. of sand and gravel for monolithic concrete and six sacks per cubic yard for reinforced concrete. Vitrified-shale paving brick was selected for the brick lining.

The concrete for the tunnel lining was put in place by the pneumatic method, with a machine made by the Concrete Mixing and Placing Co., Chicago. With this apparatus concrete was delivered through an 8-in. pipe as far as 600 ft. from the mixer. When this distance was reached, the mixer, which was placed in the tunnel, was moved up near the working face and a 10-in. shaft was sunk from the street surface into the tunnel. Materials in the proper proportion for a batch were placed in a lock on the street surface, and the air pressure was then admitted. The bottom door of the lock was opened, and the materials dropped through the 10-in. shaft into the mixer. The proper amount of water was added in the mixer, and the concrete was blown through the 8-in. pipe directly into the forms and there spread by hand. Blaw steel forms were used almost exclusively on the work.

Acknowledgment is made to J. H. Weatherford, City Engineer of Memphis, for the information and drawings from which this article has been prepared.

Grade-Crossing Elimination by Relocations

Two excellent examples of grade-crossing elimination on country roads by relocation of the highway in one case and the swapping of rights-of-way between county and railway in another are found in El Paso County, Colorado, of which C. O. Ford, Colorado Springs, is County Engineer. Both show hearty coöperation between railway company and public authorities for the mutual advantage of all concerned.

The first case is on the Ute Pass Road from Colorado Springs west. This is a section of one of the most notable cross-country tourist routes. The trail and highway are of ancient origin and of course antedated the railway. The railway, coming through a narrow cañon, crossed and recrossed the highway a number of times, some of these crossings being very dangerous because of projecting bluffs that hid the approaching trains from the view of people on the road.

A serious accident, in which several motor-car tourists were killed, led the county and railway authorities to set about the elimination of two of the worst of these crossings. It was found that by reconstructing a mile of road, two bad railway and four stream crossings could be avoided.

This relocation required some heavy grading, a section of which consisted essentially of widening the railway grade to include the highway. This section of the work was put into a separate contract, and the railway company (Colorado Midland) was the low bidder. This grading was very economically done by a steam shovel working from the railway tracks. The rest of the mile section was let to Ripley & Leslie, General Contractors, Pueblo, Colo. The total cost was $14,000, but the county engineer estimates that this sum is less than would have been required to reconstruct and maintain the four bridges on the old road.

FIG. 1. COLORADO MIDLAND RY. BUILDING HIGHWAY AS A CONTRACTOR

The other example of grade-crossing elimination in which the Denver & Rio Grande R.R. and the county

FIG. 2. UTE PASS HIGHWAY CONSTRUCTION, EL PASO COUNTY, COLO.

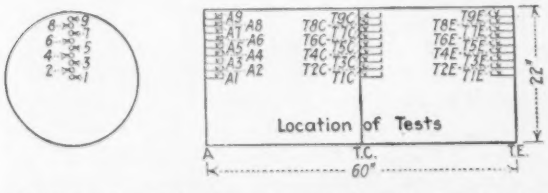
swapped rights-of-way is north of the station at Fountain, Colo. Here the original county road crossed the railway twice in half a mile. The south crossing was situated on a grade and surrounded by other conditions that rendered it unsafe. A recent accident, as before, aroused the authorities to action. The proximity of substantial residence buildings made it impracticable to relocate the highway west of the railway. It was found, however, that both crossings could be eliminated by moving the railway easterly, a change that would also improve the railway alignment without changing its gradient. The county commissioners offered to furnish a new 65-ft. right-of-way and bear one half the expense of reconstruction of both railway and highway, if the railway company would swap rights-of-way. This was accordingly done, although it required a large amount of red tape, for the railway right-of-way was encumbered with four mortgages. The railway company was represented by A. O. Ridgway, Assistant Chief Engineer. Fig. 2 shows some of the relocation in progress.

Oil Quenching Improves Solid Nickel-Steel Forgings

By C. J. Yarnall*

During the recent manufacture of nickel-steel forgings for the Quebec Bridge important questions about the effect of the oil quenching were raised. There were serious doubts as to how deep the quenching effect extends, since the forgings in question were solid forgings. In ordinary practice large forgings that must be quenched are made hollow, so that both the inside and the outside are reached directly by the oil. It was feared that in the present case there would be little or no effect in the interior of the solid forging. Whether the metal was made more homogeneous by the oil quenching was another point needing investigation.

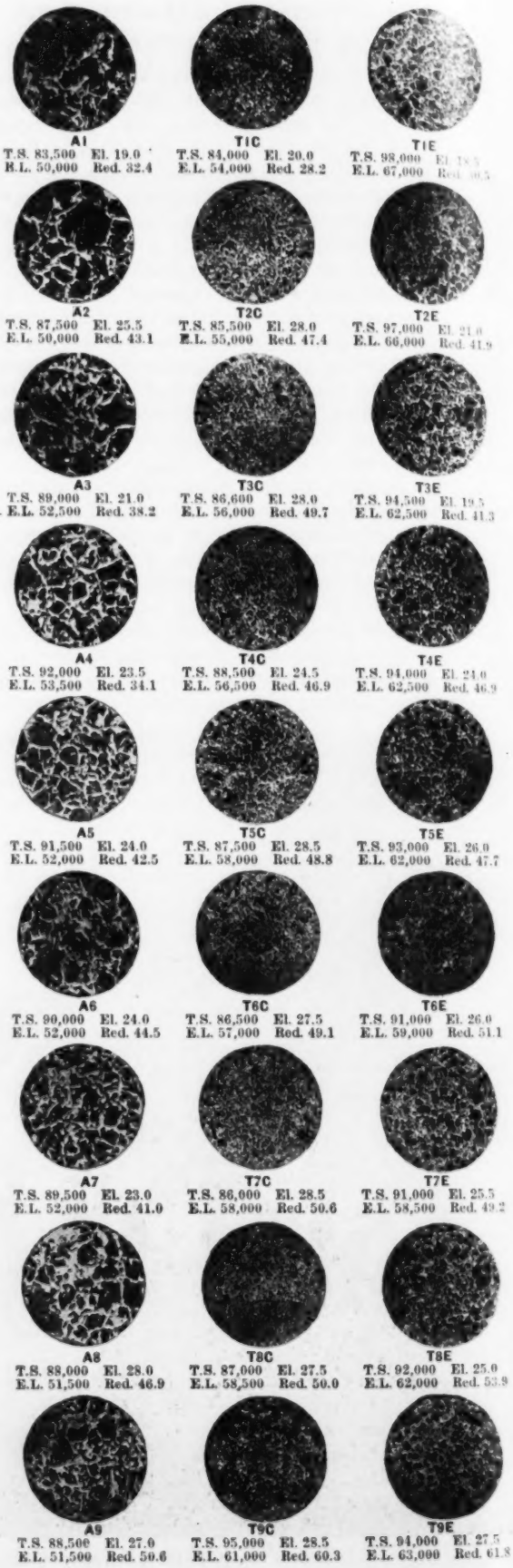
Finally, the old question of internal stresses produced by quenching was raised, and it was desired to find out whether anything in the way of internal stresses could be detected. It has always been claimed that hardening or quenching is bound to set up internal stresses due to the inequalities of contraction between the skin and the deeper-lying portions. While most persons believe that such stresses are relieved by drawing back—that is, reheating the quenched piece to a lower temperature than the previous heating and allowing it to cool slowly—there has not been enough experience with solid nickel-steel



Steel forging 22 in. diameter, forged from a 40-in. corrugated ingot. Ladle analysis: C 0.346%, Mn 0.63%, P 0.012%, S 0.031%, Si 0.050%, Ni 3.49%.
Tests A—After annealing at 1,600°.
Tests TC—After oil-treating at 1,450° and reannealing to 1,100°, middle of length of forging.
Tests TE—Same treatment, end of forging.

INTERNAL STRUCTURE OF OIL-TREATED SOLID NICKEL-STEEL FORGING (× 100)

Microphotographs of test-pieces located as shown by sketch. Threaded end of each tensile-test bar



*Chief Mill Inspector, Board of Engineers, Quebec Bridge Commission, Munhall, Penn.

forgings to make this point certain. Tests were made to try to settle these questions.

The piece selected for experiment was cut out from the middle of the forging (in order to avoid any segregation), squared at both ends to insure uniform treatment, placed in an annealing furnace, brought up to 1,600° F.

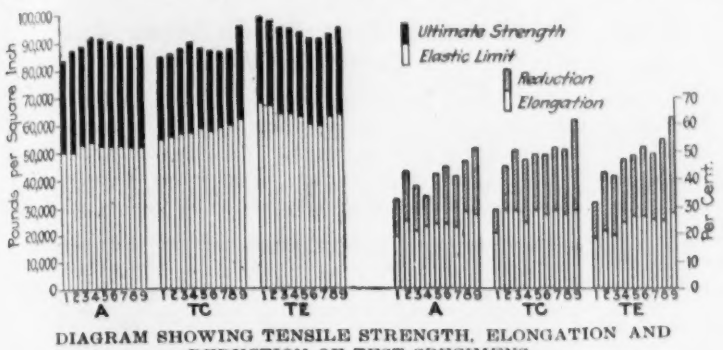


DIAGRAM SHOWING TENSILE STRENGTH, ELONGATION AND REDUCTION OF TEST SPECIMENS

and allowed to cool, then reheated to 1,100° F. At one end of the piece nine test specimens were cut out, marked *A*1 to *A*9, the letter *A* indicating "annealed" and the numbering 1 to 9 progressing from center to outside.

After these specimens were cut out, the forging was again placed in the furnace and heated to 1,450° F., immersed in oil at 85° F. and allowed to remain for 1½ hr., after which it was placed in the furnace and drawn back to 1,100° F. Then a series of test pieces was cut from the opposite end from which the annealed test pieces had been cut and marked *T*1*E* to *T*9*E*, meaning "treated forging," "end," specimen 1 to 9. Then the forging was cut at mid-length and a similar series of test pieces taken here, marked *T*1*C* to *T*9*C*.

All test pieces were slotted out in a solid block and then cut out on a shaping machine into sections 1 in. square by 4 in. long. This method guarded against distorting the pieces, as is sometimes done where a hollow drill is used and the pieces are bent back and forth until they break out. The specimens were turned to 2 in. between shoulders by ½ in. diameter and threaded both ends. Tensile tests were made on an Emery machine.

TABLE 1. CHECK ANALYSES OF NICKEL-STEEL FORGING

Carbon	Manganese	Phosphorus	Sulphur	Silicon	Nickel
		Ladle Analysis			
0.34	0.63	0.012	0.031	0.050	3.49
		Average Check Analyses After Annealing			
0.339	0.624	0.007	0.022	0.039	3.18
		Average Check Analyses After Treating			
0.372	0.73	0.010	0.034	0.044	4.58

Table 2 shows the strength and ductility figures obtained in the tensile tests.

TABLE 2. MECHANICAL TESTS OF NICKEL-STEEL FORGINGS (AVERAGES)

Ultimate, per Sq.In.	Elastic, per Sq.In.	Elongation, %	Reduction, %
	Annealed, End		
88,833	51,660	33.7	41.5
	Treated, Middle		
87,400	57,111	26.8	47.9
	Treated, End		
93,833	62,500	23.7	47.1

After the tests the threaded ends of the pieces were cut off for the microphotographs.

Chemical analyses were made of the steel in its different stages. They are summarized in Table 1 herewith. The ladle analysis of carbon is 0.346; the average of the check analyses from the nine samples from the end after annealing, 0.339; and from the opposite end after oil treating, 0.374. As the check analyses of the treated steel are all high, it cannot be said that any carbon absorption is shown. It might just as well be said that the metal absorbs manganese—which is not true, of course—as the ladle analysis is 0.63, one check analysis is 0.62 and the other 0.73. In fact, the high figures for the treated steel are a matter of personal equation on the part of the chemist.

Higher ultimate strength, elastic limit, elongation and reduction are obtained from the oil-quenched than from the annealed material, as shown by the table.

The improvement in microstructure is graphically portrayed by the series of photographs shown herewith, revealing in all cases, even at the center of the specimen, a remarkable increase in fineness of grain as compared with the coarse grain of the annealed specimen. It is evident that the heat-treatment makes the material more homogeneous and the ferrite and pearlite more intimately united. In the photographs the white areas are ferrite and the dark areas pearlite.

One of the engineers who was connected with these tests has expressed the following tentative conclusion: While there is no indication of any internal stresses in the one forging, there is a possibility of such stresses developing in another one, if a number of specimens from different heats and of different composition are subjected to the same tests.

Concrete Pavement Experience, Grand Junction, Colo.

It is quite rare to find concrete street pavements in the Rocky Mountain States, due, it is claimed, to the high price of cement in that section.

Grand Junction, Colo., is notable as having perhaps a greater yardage of concrete pavement than any other city so located. With the exception of a few asphalt-paved streets all the pavements are concrete. These were laid five years ago by inexperienced city day labor, but on the whole results have been quite satisfactory. The mistake was made in some of the earlier work of putting in contraction joints as close as 16 ft. In subsequent work the distance was made 25 or 30 ft. Most of the pavement slabs show some cracking, although rarely serious.

Various surfaces were tried—plain, scored in transverse lines about 8 in. apart and scored in crossed lines forming squares about 8 in. on a side. The former city engineer, E. R. Romberg, states that there has been no apparent advantage in the scored surface, and that it has had the disadvantage of increasing the wear from abrasion. It has had, however, one advantage in causing the cracks in many instances to follow the regular lines of the score marks and make them less noticeable and inconvenient.

The pavements are 7 in. thick at the crown, made of machine-mixed 1:2:4 concrete. They were laid in two courses, the 1¾-in. wearing surface being a 1:3 mortar.

There are about 50,000 sq.yd. in all and the average cost was $1.95 per sq.yd. The maintenance cost (filling cracks with asphalt) has been about $250 a year for the last two years only. Single course 5-in. alley pavements of 1:4 gravel concrete have cost $1.30 per sq.yd.

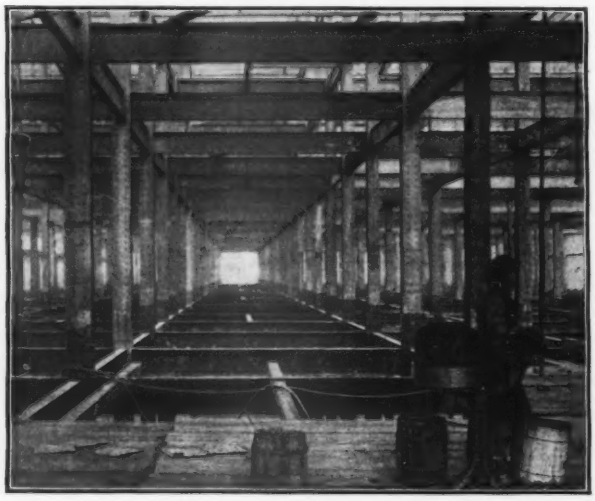
Field and Office

Temporary Flooring in Steel Buildings During Erection

The structural-safety law of Illinois provides for temporary flooring in steel-frame structures during erection. The accompanying view shows this flooring as used in the new Chicago freight house of the Pennsylvania Lines. It consists of panels of 20x22 ft. made with 2x10-in. planks 16 ft. long, laid on 6x8-in. joists of straight-grained Norway pine. The joists are 22 ft. long, laid on top of the steel beams and spaced 7½ ft. apart. The view shows only a part of the flooring in place, but the law requires the entire area to be covered.

In buildings where the height of the first two stories does not exceed 32 ft. the second floor is the first one to be covered or floored. In the freight station, however, the height is 43 ft. to the second-floor framing (24 and 19 ft. for the first and second stories respectively), and therefore it was necessary to cover the first-floor framing also. This building is 745x420 ft., four stories high, and contains about 18,000 tons of steel. The Kelly-Atkinson Construction Co., of Chicago, has the contract for its erection.

The Illinois law requires safe scaffolds not less than 16 ft. below point of work (particularly when the work is at a height of 32 ft. or more), to prevent workmen

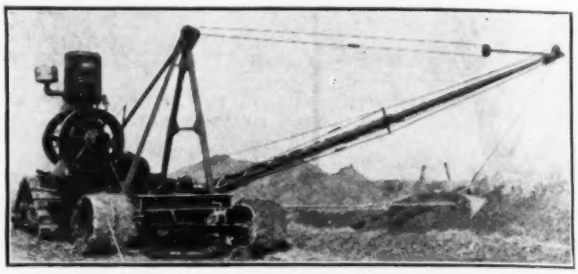


TEMPORARY ERECTION FLOORING FOR STEEL BUILDINGS, AS REQUIRED BY THE ILLINOIS SAFETY LAW

from falling in case of accident. It also requires safe temporary flooring on each story as the building progresses and not more than two stories below the level at which work is being done. The entire space must be floored, with the exception of openings for stairways, material hoists and elevator shafts. Supervision of such work, to see that the requirements of the safety law are fulfilled, is under the direction of the Illinois Department of Factory Inspection, which has its office in Chicago.

Caterpillar Backfiller for Trench Work

The trench backfilling machine shown in the accompanying view is of the dragline type and is mounted on caterpillars of a novel design. It requires only one operator. He has the four controlling levers grouped close to his seat, with a steering wheel at his right (or on the



BACKFILLER WITH CATERPILLARS AND TELESCOPIC BOOM

opposite side from the trench) and a brake treadle at his feet.

The boom has special features in being telescopic (so that it can be varied in length without dismantling) and in being swiveled so that it can be set at any angle in a horizontal plane or set parallel with the frame when the machine is traveling. Its maximum length is 23½ ft., and it has a telescopic movement of 7 ft. The heel section of the boom is composed of a pair of channels braced together, while the two outer (telescoping) sections are of pipe, stiffened by four truss rods. The boom suspension cable is led over the A-frame to a small drum on the main frame; this is operated by a worm gear, which automatically locks the drum at any position of the boom.

The 10-hp. gasoline engine drives the hoist and drag drums through chains, spur gears and friction clutches. It drives the propelling mechanism also through a chain and spur gear, with bevel-gear reverse. The main clutch, on the engine shaft, is of the multiple-disk type; this has no tendency to stick and permits instantaneous connection and release. The cable drums are 8 in. diameter, with 15-in. frictions, and are provided with eccentric-throw cone-clutches. These clutches are leather-lined and have ball-bearing thrust collars. The cables are ¼-in. for the drag, $\frac{7}{16}$-in. for the hoist and ⅜-in. for the boom suspension, with speeds of 95 ft. per min. for the drag and 115 ft. for the hoist. The scraper can handle about four loads per minute. The traveling speed of the machine is about 1½ m.p.h.

The hauling line is guided to the drum by horizontal and vertical rollers, to control any slack in the cable, while rollers in the housing of the boom sheave prevent the hoisting cable from leaving the sheave in case of a side pull. The dragline drum is set beneath the main frame, so that when hauling the scraper the overturning effect, even in making a heavy pull, is very slight. The scraper is a flat panel, with the line hitched to a bail and the

hoisting line attached to a yoke. Large handles on the rear enable a man to guide it if necessary, as when handling sticky or heavy material.

The main frame and A-frame are of steel and are mounted on wide-tired wheels or wheels and caterpillars, as desired. The latter are triangular in form (as shown) and have a length of 4½ ft. and a height of 2½ ft., with 18-in. width of platform. The front wheels are 24 in. diameter, with 15-in. face, a rib on the center of the face giving a grip in soft ground. Where caterpillars are not used, there are rear wheels of 30-in. diameter and 18-in. face. A brake, operated by a treadle, is provided on the traction gear. This is an important feature, as it puts the machine under control on steep grades or when being run on and off cars by means of inclines.

The machine is 10½ ft. long over all (9½ ft. with wheels instead of caterpillars), 7½ ft. wide and 9 ft. high. The weight is 8,000 lb. with caterpillars, or 6,400 lb. with front wheels. A smaller machine, with 5-hp. engine and requiring two men to operate it, weighs about 2,500 lb. These machines are built by the Parsons Co., of Newton, Iowa.

Excavator for Wide Cuts

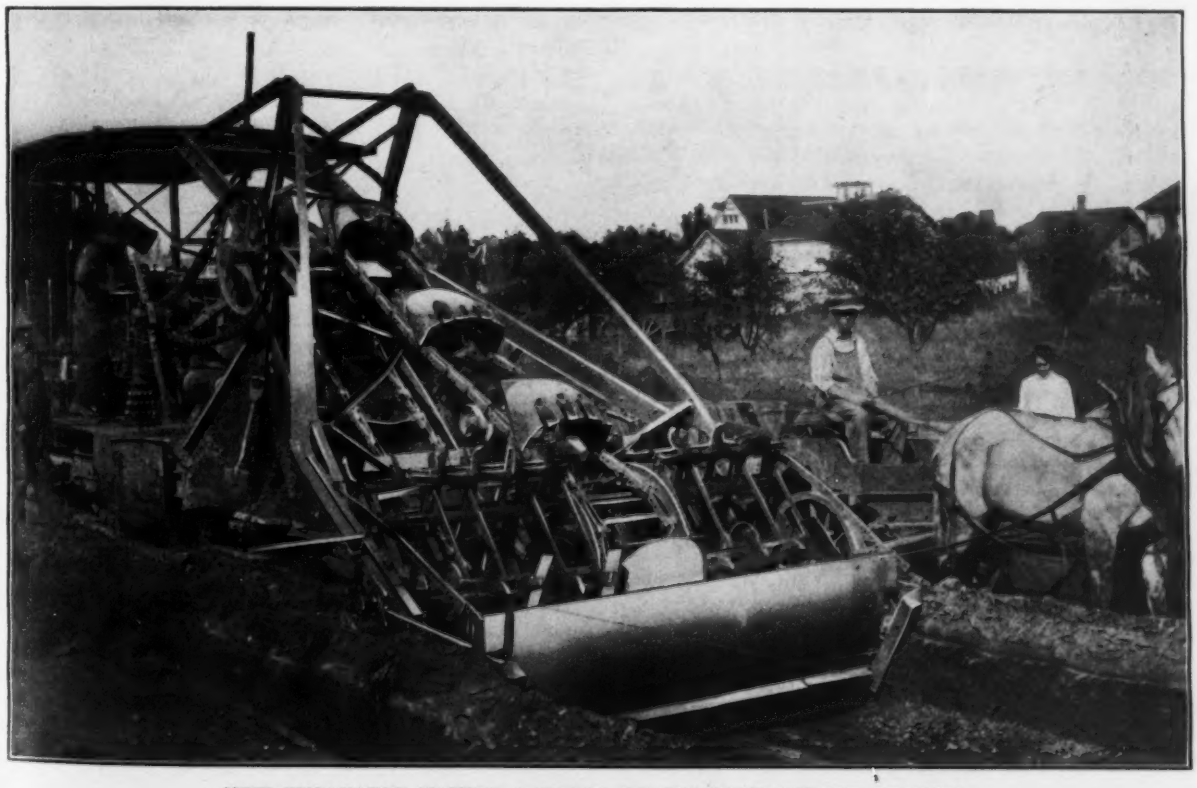
Excavating a cut 8½ ft. wide at one passage is the special feature of the excavator shown in the accompanying view. The machine is intended particularly for grading streets and street railways, where space is limited and where the material must be removed in wagons.

The excavating machinery consists of a horizontal drum 8½ ft. long and a chain of buckets. The portions of the drum beyond the buckets are fitted with teeth to loosen or excavate the machine; they have also spiral or diagonal blades 4x12 in., which are set at such an angle as to feed the excavated material toward the center, within reach of the buckets. From the buckets the material falls upon a lateral belt conveyor that delivers it to the wagons. The machine is 40 ft. long, with a maximum width of 9 ft., and weighs about 14 tons in running order. It is driven by a four-cylinder Buffalo gasoline engine of 24 hp.

The excavation can be done for depths ranging from 2 or 3 in. to 5½ ft. The cutter chain works on a boom that is adjustable by a screw, and an indicator is provided so that the operator can raise or lower the boom as required to keep to the grade line. It is found desirable to excavate slightly below the finished grade and then to dump sufficient material from wagons and roll it to grade. This is cheaper than to keep the cut above the grade line and then trim it down by hand labor.

For street work it is best to make the outside cuts first, cutting to a line to allow room for the curb and gutter and the concrete forms. On these side cuts the excavator is pitched to conform to the crown of the street, but on the center cut it runs level. Where the total width is a little over the 25½-ft. cut made by the machine (in three passes), the center cut is made a little deeper, so that the excess material on either side can be leveled down to fill the bottom of the cut and be rolled to grade. At alley intersections the cut is taken out to a greater depth for a distance of 16 to 24 ft., and then the material in the intersections is plowed and shifted into the cut with slip scrapers.

In excavating for street-railway track, where the trench is usually 8½ ft. wide and 18 to 20 in. deep, the cut is made in one operation. The machine will excavate old macadam paving if the cut can be made



NEW EXCAVATOR MAKING A CUT 8½ FT. WIDE FOR STREET GRADING

at least 2 in. deep. It is seldom necessary to plow or root up the street in advance, as the cutting drum of the machine is equipped with sharp and narrow cutting teeth.

These machines were designed and built by the General Engineering and Construction Co., Rockford, Ill., for use on its own street-grading contracts and have been operated during two seasons.

Wire-Drag Surveys and Recent East River Results

By N. H. Heck and J. H. Hawley*

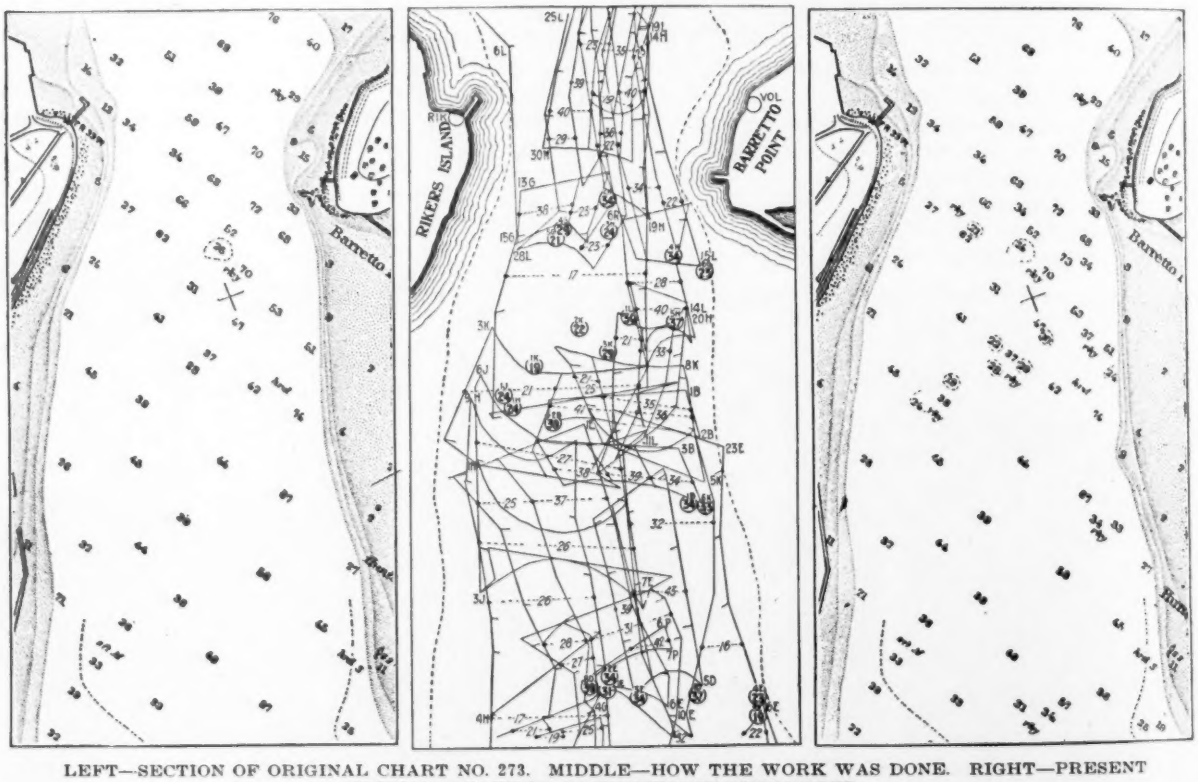
In 1915, from May to November, wire-drag work was actively prosecuted by four parties of the Coast and Geodetic Survey. The approaches to Boston and the doubtful area adjoining the coast from Boston to the Cape Cod Canal were examined from Swampscott to Plymouth; Quicks Hole, an important entrance to Buzzards Bay, was resurveyed by the wire-drag method; Eastern Passage of Narragansett Bay was dragged to meet the demands of the important naval station at Newport, as well as of Fall River and Providence; and the main channel of the East River, New York, from Lawrence Point to Whitestone Point was examined.

In Alaska the work was started in 1914, and at the close of the second season approximately one-third of the main through route from the international boundary at Dixon Entrance to Skagway, the most northern port in southeastern Alaska, had been completed. Actual menaces to navigation have been discovered to the number of 45, the importance of which can be expressed by the statement that in 90 mi. of these channels there are 12 buoys marking dangers to navigation, 5 of which were found by vessels striking them, 2 by general surveys and 5 with the wire drag.

On the Atlantic Coast important shoals were found in each region examined, especially between Boston and the Cape Cod Canal and in Quicks Hole, where existing ideas as to the extent and location of channels had to be revised. Fifteen shoals of 26 ft. or less were found (25 ft. is the present depth of the canal).

The work in the East River is especially interesting, both because of the surprising results obtained in a constantly used channel and because the unusual conditions required a modification of the ordinary methods. The three illustrations show, first, the chart as it appeared prior to the resurvey; second, a section of the smooth or final hydrographic sheet, showing how the work was done and the shoals found (the figures surrounded by circles are the depths on shoals referred to mean low water); third, the chart as it now appears.

Three of the pinnacle rocks, with depths of 19, 21 and 22 ft., are dangerous obstructions in a channel considered safe for vessels of 24-ft. draft. As Fig. 2 shows, unusually short drags (from 200 to 1,200 ft. in length) were used. Because of the very strong currents it was not generally practicable to change the depth of the bottom wire after starting or to clear the wire and proceed after finding the shoal. It was necessary to divide the area into sections of varying sizes where the depths were reasonably uniform and to examine these sections separately with a suitable length of drag set at approximately the same depth throughout.



LEFT—SECTION OF ORIGINAL CHART NO. 273. MIDDLE—HOW THE WORK WAS DONE. RIGHT—PRESENT EDITION, SHOWING OBSTRUCTIONS DISCOVERED

*Assistants, Coast and Geodetic Survey, Washington, D. C.

The congested traffic at all times interfered with the operations and made it especially difficult to set out and take up the drag, which had to be done every time a shoal was found. During the dragging the guiding launch kept as nearly as practicable to a prearranged line, while the end launch kept a tension on the wire by heading at nearly right angles to the direction of progress. Nearly all of the forward motion of the drag was due to the currents. Ranges were used, and no attempt was made while dragging to plot the observations, which were taken at frequent intervals. This is reflected in Fig. 2.

The operation may be described as the development, by means of a wire under tension, of a horizontal plane at a fixed depth below a datum plane (in this case mean low water). The aim in channel work is to keep the planes as near to a predetermined depth as practicable and, when projections above them are found, to prove the surrounding depths correct, as well as those on the projections. This was not entirely practicable in the East River, but the value of the practice is evident when it is realized that the discovery of these shoals makes their removal necessary.

By comparing the depth found on shoals with the depth of the wire that first found them, the amount of projection can be seen. In some cases the previously charted depth was much greater than the depth of the drag wire, the extreme difference being 22 ft.

The summary of results to Dec. 31, 1915, from the beginning of wire-drag work in 1904 follows:

	Sq.Mi. Dragged	No. of Shoals Found
Atlantic Coast and Porto Rico	1,188	2,819
Pacific Coast, including Panama and Alaska	812	373
Total	2,000	3,192

The plans for next season's work on the Atlantic Coast include the completion of the doubtful area between Nahant and Cape Ann and between Plymouth and the Cape Cod Canal entrance; in western Long Island Sound, continuing the work done in the East River. In Alaska the dragging of the main channels of southeastern Alaska will be continued.

Discussion of Conductor Heads for Roof Drainage

By Albert M. Wolf*

One sees very few sets of building plans that contain details of the heads for rainwater conductors provided to carry off the roof drainage. In general, conductor-head details are covered entirely by the specifications and a short note on the roof plan, somewhat like this, "Provide heavy copper or cast-iron strainer at all downspouts." The specifications merely state that all conductor heads are to be formed of a copper pan or funnel flashed into the end of the conductor and the open end of the pipe protected by a copper screen or a galvanized-wire strainer.

In some cases, where a conscientious roofer has the job, a good conductor head will be constructed even under such a loose specification as the foregoing, while in others more often just the opposite may be true. It may seem to some that this is a trivial matter in the construction of a building, but in the writer's opinion it deserves much more attention than it usually receives. Instances have occurred where the downspouts provided for roof drainage have seemed inadequate when, as a matter of fact, the conductor-head construction was of such a flimsy character and so poorly arranged as to shut off the conductor almost entirely through accumulations of gravel, leaves, dirt, etc. Then again some consideration as to the type and pitch of the roof should be given when detailing the conductor head and fixing the size of the conductor. It is apparent that the same conductor-head detail and the same size of conductor should not be used for equal areas of flat and pitched roof, yet we quite often see downspout details for saw-tooth roof construction which are wholly inadequate, since they were originally developed for flat, or nearly flat, roofs.

The common practice in determining the proper size of downspout is to provide 1 sq.in. of conductor area for each 100 sq.ft. of area of what are commonly known as flat roofs (slope ¼ in. to ¾ in. per ft.) in the Central States and 1 sq.in. of conductor for each 75 sq.ft. in localities where the rains are more severe. For roofs of greater pitch the areas to be cared for by 1 sq.in. of conductor should be decreased in the following ratios: 15% for ½ pitch and 25% for ¾ pitch. In no case should a downspout be less than 2 in. in diameter and preferably not less than 4 in.

The conductor head should be of such size and arrangement as to present about twice or three times as great a width or diameter as the conductor, so that even if a portion of the screen should become clogged or stopped up with débris there will still be sufficient inlet area to carry away the water without flooding the roof.

As previously stated, the downspout arrangements for saw-tooth roofs demand special attention in order that satisfactory results may be obtained. On such roofs it is highly essential that downspouts be placed in each line of valleys and that they be designed to serve a much smaller area than for ordinary roofs of the same pitch. In winter there is always a tendency for snow to drift into the valleys; and in mild weather, when alternate thawing and freezing take place, difficulties of getting the water to the conductors are sure to be experienced unless they are spaced fairly close together and the screens or strainers carried up some distance above the roof line.

Wherever practicable, the downspouts should be placed on the inside of the building, to prevent freezing and bursting in winter. It will be found that wrought-iron pipe gives better satisfaction for interior conductors than cast-iron pipe, since it can be obtained in longer lengths, is not as heavy, requires no calking (threaded sleeve connections being made between sections) and does not take up as much space as hub and spigot cast-iron pipe.

Discussion of Different Types of Conductor Head

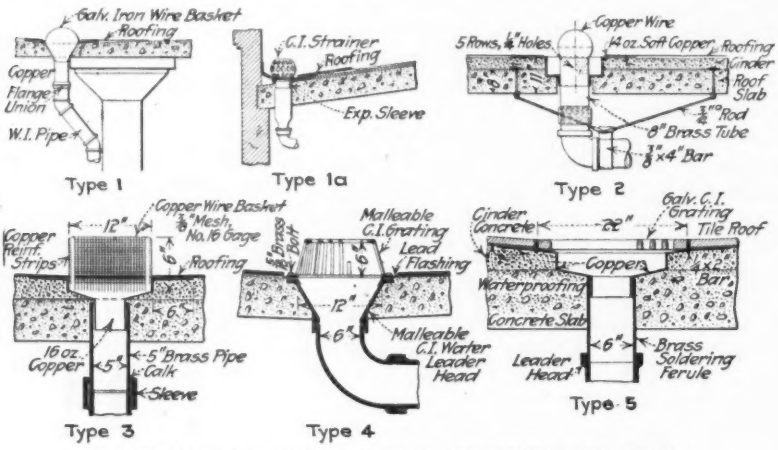
Type 1—Probably the most common type of conductor head is that given in the drawing as type 1; and when no other detail is shown on the plans, this represents fairly well what the owner gets. From the figure it can be seen that this conductor head consists primarily of a balloon-shaped galvanized- or copper-wire strainer soldered to the copper sump box of funnel shape, which is in turn soldered to the downspout connection pipe.

This construction is about the cheapest one that affords a guard against gravel, leaves, paper, etc., going down the conductor. Quite naturally it is not very permanent or strong and is subject to the danger of being easily misplaced or broken down. For this reason it should be used

*Principal Assistant Engineer, Condron Co., Chicago.

only on the cheaper class of buildings and those of a more or less temporary character. For large buildings of steel and concrete construction some one of the more permanent types should be used.

As a general rule the exposed area of the wire strainer is not large enough to allow sufficient water to enter the conductor so that it will work at anywhere near its normal capacity. The screen not being made as large as the sump box, the latter soon becomes filled with gravel, cinders and dirt, still further reducing the capacity of the downspout. Frequent inspection is therefore necessary, but this is very seldom given unless the roof is used for some purpose or other, such as a playground, testing-ground or roof-garden, in which case a conductor head of this style is entirely out of place, types 4 and 5 being the logical ones to use. These latter, being very strong, eliminate any danger of injuries due to stepping into downspout sumps, while the opposite is true of type 1, which is at best a flimsy protection.



CROSS-SECTIONS OF FIVE TYPES OF CONDUCTOR HEAD

Standard cast-iron downspout heads of the form shown in type 1-A are often used for small-sized conductors. The disadvantages of this kind of strainer are the same as those just cited. They are, however, much more stable and permanent than wire baskets. The prime disadvantage is that the openings in the strainer are not sufficient for the size of the pipe to which they are attached; and if conductors are not considerably oversize, flooding of the roof may take place during heavy storms.

Type 2—A modification of the type 1 conductor head is shown as type 2. In this head a copper-ball wire strainer is soldered to a copper ring punched with ¼-in. diameter holes near the top and is set in a square copper sump box of slightly larger size than the strainer, the whole being soldered to a brass tube threaded into the downspout.

This form of leader head is a considerable improvement over type 1, but nevertheless it possesses some of the latter's disadvantages. The exposed area of the strainer is not enough larger than the conductor to allow it to operate at full capacity. The screen not being made as large as the sump box, the latter soon becomes filled with a mixture of gravel (from roofing), cinders, dirt, leaves, etc., that still further reduces the capacity of the intake. By sloping the sides of the sump box slightly, as in type 3, the dirt will tend to wash down the conductor instead of lodging in the box, but accumulations around the head can be prevented only by using a large guard over the downspout, as in type 3.

Type 3—The conductor-head detail designated type 3 might be called another modification of type 1. This head consists of a square basket of No. 16 copper wire of ⅜-in. mesh soldered to the sump box, with sloping bottom formed of 16-oz. cold-rolled copper, with a tube at the bottom fitted into and soldered to a brass soldering ferrule. This ferrule is then calked into the wrought-iron or cast-iron conductor pipe.

The wire basket should project above the roof a height about equal to the diameter of the conductor, and the corners should be reinforced with strips of copper to give greater rigidity. By making the basket about twice as large as the conductor pipe the danger of the screens becoming stopped up is reduced to a minimum and flooding of the roof is avoided.

For buildings of permanent construction where the roof is little used or inspected, this conductor will give good service. It is adapted for comparatively flat roofs or those with considerable pitch, and viewed from the standpoint of simplicity and ease of erection, it merits extensive installation, except on buildings where the roof serves various purposes.

Type 4—A conductor head of very nearly permanent character is shown as type 4. It is applied to a concrete roof with a fairly flat slope formed by pitching the slab itself and not by cinder saddles. The head consists of a malleable cast-iron grating of about twice the diameter of the conductor projecting above the roof line a distance equal to the diameter of the downspout. Brass bolts connect the conductor head to a funnel-shaped malleable cast-iron water-leader head.

This conductor head is of excellent design, since it has a very strong grating with a large portion of its surface open for the passage of water and is rigidly connected to the funnel-shaped leader head, thus preventing the accumulation of dirt in or around the head. It is particularly suitable for large concrete buildings where the roof is subjected to more or less use, such service necessitating a conductor head that cannot easily be broken down.

A Flush Grating for Utilized Roofs

Type 5—The utilization of the roofs of buildings as playgrounds, roof-gardens, automobile testing-grounds, etc., has greatly increased in the past few years. For such roofs it is highly essential to provide a conductor head of such construction as not to obstruct the roof surface. In type 5 is shown a conductor head of this kind, which has been placed with good results on a large number of concrete buildings the roofs of which are covered with promenade tile.

The head consists of a flat square cast-iron bar grating set over a copper sump box, with sloping bottom and circular outlet, soldered to a brass soldering ferrule that is calked into the conductor pipe. To prevent water from backing up under the tile covering the copper sides of the sump box flashed thereunder, the copper is carried up over a steel bar set alongside the grating and flush with it.

It will be noticed that the openings in the grating are quite large, in fact much larger than those in any of the other styles. This is because it was designed for use on promenade-tile roofs rather than for a roof with tar and gravel covering, the gravel from which might soon clog the grating. The one objection to this style of roof sump is that it can be practically stopped up by papers, etc., owing to its being perfectly flat. Where such sumps are used, however, at least a few persons are on the roof each day and the chance of a downspout being left in a plugged condition so as to flood the roof is rather remote.

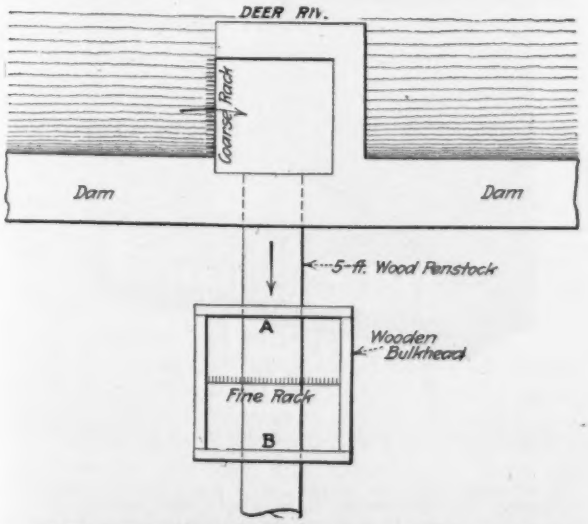
For permanent buildings of good construction only the last three types can be recommended as being consistent with good building practice. Although they cost considerably more than the others described, their installation is money well spent.

Ice Pipe Carries Power Water While Screen Is Installed

A fine-screen rack was built this winter in the wooden penstock line of the Deer River Power Co. at Copenhagen, N. Y., and it was found possible to facilitate the work without interrupting service by the unusual expedient of using an ice lining to carry the water. Water is conveyed to a power plant through a penstock consisting of a wood-stave pipe 5 ft. in diameter. The head is 175 ft., but the upper portion of the penstock is not under pressure. A wooden bulkhead (see illustration) was built around the penstock just below the intake. It was proposed, in order to install the fine rack, to shut down the plant for a couple of days while a section AB of the wooden pipe was cut out and the screen was being placed in position.

On cutting the staves of the wooden pipe it was found that there was a 9-in. layer of hard ice inside the pipe. Accordingly, care was taken not to disturb this ice pipe while the remaining staves were cut away. Holes were bored through the ice, and through them the 3x¼-in. trash-rack bars were inserted in place.

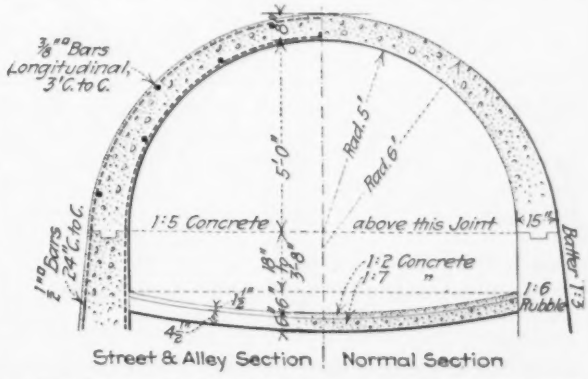
Using the natural ice sluice in this way, it was possible to work practically dry within the bulkhead while securing the rack bars in position. The job was completed with water flowing through the ice pipe and filling it half full, thus providing for the power requirements and avoiding a shutdown of the plant.



ARRANGEMENTS FOR BUILDING SCREEN RACK, COPENHAGEN, N. Y.
Ice pipe left between A and B after removal of wood penstock

Scarcity of Steel Results in Plain Concrete for Sewers

The high price and slow delivery of steel are driving engineers to various expedients of construction to eliminate all the steel possible from their structures. In Austin, Tex., the city engineer, M. C. Welborn, has under way about $50,000 worth of storm sewers and the replacing of a number of bridges washed out during the floods of 1915. Several of these structures have been redesigned as plain concrete arches, the additional concrete being cheaper than reinforcing steel at the prevailing prices. Moreover, 100 tons of steel ordered by the city last summer had not been delivered by Mar. 1, 1916.



CROSS-SECTION OF ARCH STORM SEWERS, AUSTIN, TEX.

Storm sewers of 8-, 9- and 10-ft. semicircular arches are being constructed of plain concrete, to the cross-section shown herewith. These sewers are under the sidewalk areas (sidewalk or parking), where they will carry no heavy street loads except at street and alley intersections. Here the reinforcement shown in the left-hand part of the cross-section is used.

In these reinforced portions all arch rods extend 3 ft. below the springing line of the arch.

The arch concrete is mixed 1:5 and the arch abutments 1:6. Rubble stone is used wherever the size of the member is sufficient. The 6-in. invert is made in two courses. The bottom course is 4½ in. of 1:7 concrete, and the top course is 1½ in. of 1:2 concrete for resistance to abrasion.

For small sewers, concrete pipe is used in Austin. This is unreinforced. A city plant for making the pipe has been in operation several years, and the results are quite satisfactory.

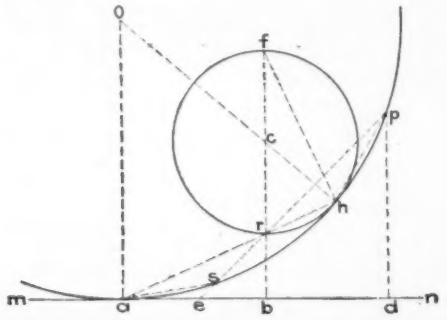
A natural gravel aggregate obtained from the Colorado River bed is used.

Locomotive Crane with Generator-Car Trailers is a novel arrangement devised by necessity. Some time ago the Pennsylvania Railroad Co. bought four 30-ton locomotive cranes from the Ohio Locomotive Crane Co. (Bucyrus, Ohio). Recently it was desired to equip two of these cranes with lifting magnets, but there was no room on the crane car for the necessary electric generator. Consequently a small flat trailer was built and a generator set installed on board. Both of these cranes are now in service.

NOTES

An Infiltration Gallery for the water-supply of Lockhart, Tex., is being developed by Henry E. Elrod, consulting engineer, Dallas, Tex. The city is situated on a bed of gumbo soil about 10 ft. deep which overlies a saturated bed of sand and gravel. To tap the groundwater, a trench 10 ft. wide, 140 ft. long and 25 to 30 ft. deep is excavated. The sides of the trench are supported by concrete walls, and the bottom is left open. The water thus intercepted will flow to a sump at one end of the trench and be pumped thence to the city mains.

A Railroad Turnout Problem; Geometrical Solution—A problem that is not uncommon in detail location of railway tracks is treated by C. G. Edwards, Southern Pacific Co., San Francisco, Calif., by the following interesting method. The problem was to run in a curve from a given tangent to pass through a given point and to pass at a prescribed distance from the corner of a building. The point and the corner of the building are supposed to be tied in to the tangent. In

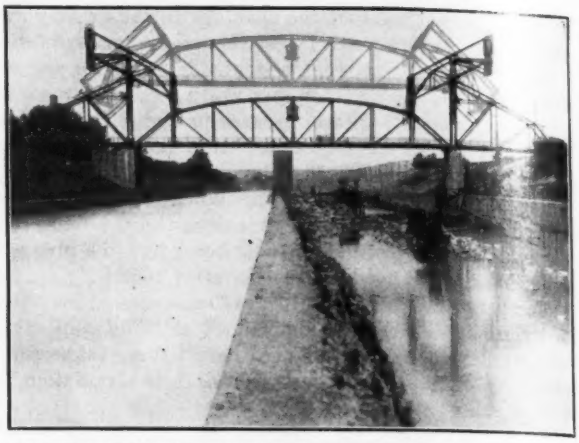


TURNOUT PROBLEM, GEOMETRICAL SOLUTION

the sketch mn is the given tangent, p the given point and c the corner of the building. A circle rhf is drawn around c with the prescribed clearance distance ch as radius. The required turnout is represented by the curve shp with center at o. Joint a and h. This line intersects the small circle at r, which is in the vertical line below c, as can readily be shown by similarity of the triangles chr and oha. Draw other construction lines as shown. The triangles asr and phr are similar, which gives the equation $sr \times rp = rh \times ar$. Also the triangles abr and rhf are similar, which gives the equation $rh \times ra = rb \times rf$, substituting which gives $sr \times rp = rb \times rf$. In this equation all quantities except sr can be calculated from the known positions of points c and p with respect to the line mn. Then sr is computed, and from it se and sp can be found. As ae is a mean proportional between se and sp, the beginning of the curve is fixed. It is then a simple matter to find the radius.

Adding Machines used in Field by Leveling Parties—The precise-leveling parties in charge of J. H. Peters and G. D. Cowie of the United States Coast and Geodetic Survey, operating in Indiana and Florida, respectively, are recording the readings of the level rods on adding machines as the work progresses. The machine is strapped to the top of a motor velocipede on which the party goes to and from the working ground. The leveling is done along railroads, and the car is moved forward with the observer as the work progresses. The adding machines are now being used in the field for the first time in such work. From the results up to now it is concluded that recording can be done more quickly and with less likelihood of errors than when the recorder uses the old method of entering the observations in a record book. Backsights and foresights are recorded in separate columns, whose sums may be obtained by pulling a lever. The difference between these two sums is the difference in elevation between the starting and ending benchmarks of the line. The machine is of the listing type, so that it gives a permanent record of the observations on the reel of paper. The saving of time and money in a single season will much more than pay for the cost of the machine in the opinion of officials of the Survey.

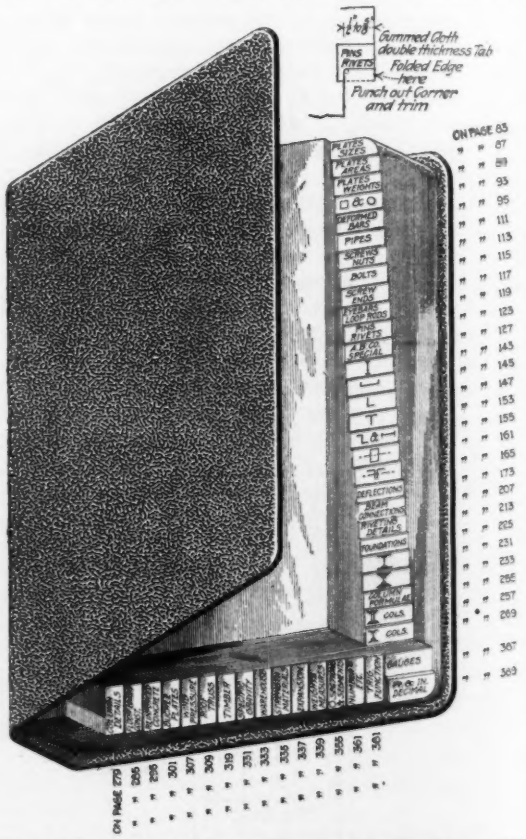
Moving Picture of a Lift Bridge—The Strauss direct-lift bridge over the Louisville & Portland Canal, near lock and dam No. 41, Ohio River, at Louisville, is shown in an interesting manner in the photograph. Both positions of the bridge are shown by clever superposition of the photographic printing. Five bridges of this type have been built up to



"MOVING PICTURE" OF LIFT BRIDGE OVER LOUISVILLE & PORTLAND CANAL

the present, the earliest in 1910. The Louisville bridge is the most recent. Its completion was noted in "Engineering News" of July 15, 1915, p. 123. It spans 210 ft. in the clear. The lift is 40 ft. and gives 90-ft. clearance above normal stage.

Index for Steel Handbook—Herewith is a sketch of a convenient thumb index for the Carnegie handbook. This index is in use at the county engineer's office in Pittsburgh, and it was worked up by A. D. Nutter, structural engineer in that office. Others might find another index more suited to their work, but the mechanical make-up would be the same. About



THUMB INDEX FOR CARNEGIE POCKET COMPANION (1913 EDITION)

45 headings can be placed on a page of the handbook. Although the 1913 edition is more complete than the old one, yet many readers have found considerable trouble in locating information, and the difficulty is increased by the thin paper used. The tabs are a considerable help in consulting the handbook.

Editorials

Reviving the Natural-Cement Industry in America

Attention was called in these columns two years ago to the importance of preserving the natural-cement industry, which has been steadily declining during the past fifteen years until the output of natural cement has fallen considerably below a million barrels per annum.

In view of the high prices now prevailing for portland cement, the present is a particularly favorable time for renewed activity in the natural-cement industry. It is of interest to observe that one large producer of natural cement in the Middle West has undertaken an active campaign to reëstablish natural cement in the favor of engineers. There is no doubt that one reason why portland cement has so largely crowded out its old competitor is the extent to which it has been advertised as a superior material.

That portland cement is superior for many uses is beyond question; but as was pointed out in these columns two years ago, the older generation of engineers, at least, is aware that natural cement possesses qualities that make its use advantageous in certain places. The buttery consistency of mortar made from natural cement makes it valuable in laying brick and stone masonry. Its slow-setting quality, while on many works a drawback, is in other places an important advantage.

In laying street-pavement foundations, for example, it is now the universal practice to haul the sand and stone and dump it in the street, from which it is shoveled, with more or less street dirt, onto the mixing platform or into the mixer. By the use of a slow-setting cement, however, it would be possible to establish semi-permanent concrete-mixing plants, where the material would be discharged from bins directly into the mixer and the mixed concrete would be hauled in tight dump-carts from this mixing plant to the place where the concrete is to be used.

The durability and reliability of natural cement are attested by the condition of most of the older engineering works in this country built prior to 1880. It is the general experience that where natural cement was used for foundations the work is generally in perfect condition, while works in natural cement exposed to weather and frost action show more or less deterioration. Exactly the same thing could be said, however, concerning works which were executed in portland cement and which have not had nearly as long exposure.

It is also a fact that where old structures of natural cement are torn out at the present day a large variation is found. Some of the work is as hard and sound as a good natural stone, while other work crumbles readily and is easily excavated with hand tools. When the conditions are recalled under which natural cement was manufactured and used fifty years or more ago, it is not at all difficult to understand why such variations in condition should occur. Cement manufacturers of that day were working to a large extent in the dark, with rule-of-thumb methods and without the aid of applied chemistry. The engineer who used cement, also, was in many cases ignorant of the care necessary in its mixing and manipulation, to secure reliable results. It ought to be possible with modern methods of manufacture of natural cement and with the same care in its use as is exercised with portland cement to carry out work with natural cement that would be even better than the monumental work done with it two generations ago.

Soft Ground Tunneling

Engineers interested in tunneling work will read with interest the description elsewhere in this issue of the methods adopted at Memphis, Tenn., in driving two soft-ground tunnels as a part of a new storm-water drainage system. Each of these tunnels is nearly half a mile long, and work on each of them was begun with steel shields forced forward by hydraulic jacks.

These shields were of much lighter construction than those which have ordinarily been used for subaqueous tunneling. The shells were a single thickness of $\frac{5}{8}$-in. plates, there was no interior diaphragm, and the interior bracing was light. In one of these tunnels the shield was successfully used throughout the work. In the other tunnel, of somewhat larger diameter, the shield failed after the tunnel had been driven a short distance. It was repaired and reinforced at a heavy outlay in time and money, but again broke down and was abandoned, and the remainder of the tunnel was driven by other methods.

It is sometimes a difficult question to decide whether the conditions under which a soft-ground tunnel is to be driven are such as to call for the use of a shield. Of course, where a tunnel is to be driven under a body of water through running ground, shield tunneling is necessary for safety. In most soft-ground tunneling, however, the work can be done, if necessity requires, with ordinary methods of drifting and timbering, supplemented if necessary by the use of compressed air and by the drainage of ground in advance of the tunnel by wells.

Where the use of a shield is decided upon, it should be made strong enough to stand the heavy stresses upon it. A tunnel shield may have to carry the load of the entire over-burden above the tunnel roof. The jacks that force the tunnel forward may exert a pressure of a thousand tons or more; stones, logs and other obstructions to the shield's cutting edge may tend to distort the shield.

The temptation to economize in shield construction is especially great where the shield is used for a short tunnel. The stresses on the shield, however, may be as great in a short tunnel as in a long one; and if it is worth while to use a shield at all, it is sound economy to make it amply strong for its work.

The Largest Reservoir in North America

The largest reservoir in North America is being created in the Province of Quebec. It will store 160 billion cubic feet of water and allow the regulation of the St. Maurice River so that some 168,000 hp. more is available as steady power at three points below. This reservoir is to be compared with the next largest in North America, the Elephant Butte reservoir of the United States Reclamation Service, in New Mexico, having an eventual 115 billion cubic feet of impounded water. The St. Maurice reservoir is exceeded in the list of the world's largest only by Gatun Lake, at Panama (183 billion cubic feet), and the Nile River above Assuan (3,750 billion cubic feet).

This project is of timely interest as the first storage and river-regulation scheme for power to be actually undertaken in America that can approach the description "enormous." The magnitude here is of flooded area and impounded water rather than cost of works, being in the natural-lake region of the St. Maurice headwaters.

The dam for this reservoir, the design and construction of which are set forth elsewhere in this issue, is not an unusual structure. The matter that will excite the greatest interest in the dam itself is the selection of the solid-gravity section instead of the hollow-deck design, where the transportation is so peculiarly difficult as at St. Maurice. The reason, it appears from the reports, was the caution which the Streams Commission and its engineers desired to exhibit in this their first great undertaking. Mingled with their caution there seems to have been an underlying feeling that the prestige of a government project and a great artificial lake required the sort of monumental and everlasting structure afforded by solid masonry.

In this particular case the saving of a hollow dam over the solid type is minimized. This structure is a long low structure for the most part, in which the yardage of decks, buttresses and aprons would begin to approach the yardage of a solid dam. Moreover, much of the cost of the work is represented in the cost of providing means of transportation, getting equipment to the site, maintaining the labor force, etc.—all items that would yield no appreciable reduction in the construction of a hollow dam.

Looking at the dam and reservoir from another viewpoint, the advantages of the location are shown in new light. The quantity of concrete needed is 70,000, the reservoir capacity created is 160 billion—a unit figure of 0.44 cu.yd. of concrete per million cubic feet. What this means may be seen by noting the Elephant Butte (solid-gravity section dam) ratio of 4.78 cu.yd. per million cubic feet and the 2.3 figure for the Aziscohos dam (hollow-deck type)—both of which may be taken as the nearest representative cases.

Some question naturally arises as to how the province can afford to go ahead with as large and expensive a project as this while the nation is at war. To see the answer, it is necessary to know something of the unique power situation in the city of Montreal—for current from the most important power developments benefiting from this project (Shawinigan and Grand' Mère) is controlled by the Montreal power utility. There is immediately available for this concern about 123,000 hp. more of steady power than before, and this is worth at least $1,250,000 per year in gross income. The Montreal district is supplied by five large hydro-electric stations with a possible output of some 400,000 hp., and the installed capacity of all these stations is practically loaded its full extent. Such a condition discloses the willingness of private interests to invest money in the improvement of the St. Maurice River.

The reported method of financing the work also is worthy of passing mention, as being affected by the exigencies of the times. The contractor is paid in the Government's bonds, and the benefited interests pay the interest and amortization. But the contractor also represents the power interests, so that, waving legal niceties aside, the benefiting concerns pay the interest on the bonds that they themselves hold. Apparently a desirable end is secured; the Government controls the design, construction and operation, but the entire financial burden is assumed by the power companies. The riparian owners gain by the elimination of intercompany agreements to coöperate in the improvement; arrangements difficult to secure and troublesome to maintain. Apparently each party gets a maximum of what it wants and a minimum of what it naturally would like to escape.

Federal Permits for Water-Power Development

The National Conservation Association at its meeting in Washington last week voted by a large majority to approve the Shields bill, which authorizes the Government to grant fifty-year permits for the development of water power on navigable rivers. Under this bill the development of the power will be under Government supervision, and the rates charged by any company which develops power will be subject to regulation by the authorities of the state in which the plant is located.

The Shields bill has been opposed by Gifford Pinchot and his associates on the ground that it is too generous in its terms to the companies which develop the power and especially that the companies receiving the permits should pay some compensation to the Government in addition to that provided in the bill. Mr. Pinchot's theory is unquestionably sound; but the difficulty lies in its practical application. It sounds reasonable to say that, if the Government is to sell or lease valuable propery, it should get the best price the property will bring rather than give it away. But how could a price be fixed which would be fair both to the Government and the people who invest their money in water-power development? It is easy to say that the price should be such as will leave a fair return to the company on its capital invested plus suitable compensation for the risk involved and a reward for the enterprise and industry necessary to organize the corporation and carry the work into effect.

The difficulties of carrying any such ideal plan into effect are insuperable. No engineer or financier is wise enough to predict in advance with any considerable degree of accuracy what will be the annual net earnings (or losses) of a great water-power enterprise five years, ten years or twenty years from the date of its establishment. Unless such an estimate could be made, how would it be possible to appraise the different water-power sites and determine their present-day value or what

would be a fair rate of compensation for their use? It might be possible, of course, to fix by law or executive order a certain rate of compensation for all Federal water-power leases; but under such a plan only the most favorable power sites would be developed and the others would remain idle.

Everyone agrees that it is to the interests of all parties concerned and especially desirable for the conservation of our coal and oil resources that water-power development should again go forward on a large scale. The Government itself obviously cannot go into the business of power development, and it ought therefore to encourage private corporations to carry forward this work and to do so at the earliest possible date.

It is this general view of the matter, we take it, that influenced the National Conservation Association at its recent meeting to reverse its action of three years ago and approve a more liberal policy toward the development of water power.

Road Maintenance Experience in New York State

Engineers interested in highway work will read with interest the paper by T. M. Ripley, one of the Division Engineers of the New York State Highway Department, recounting the experience of that state in road maintenance. It is common enough to hear the blame laid for the unsatisfactory character of New York state roads to the prevalence of graft in the state government, to a defective organization, to corruption in politics, to incompetence of the men who planned and built the roads, to mistakes in the selection of the type of road to be built. Each and all of these assigned causes have had something to do in producing that result, but the most important cause of all, well set forth by Mr. Ripley in his paper in this issue, is the rapid and revolutionary series of changes in the traffic upon these roads. No one could foresee these changes fifteen years ago or ten years or even five years ago, and the changes which are even now going on have a very important bearing on the type of road that should be constructed in future and the methods which should be adopted for its maintenance.

We may refer specifically to the concluding paragraph of Mr. Ripley's statement, in which he calls attention to the terrific damage which is being done to macadam roads, both waterbound and bituminous, by the rapidly increasing traffic of motor omnibuses and motor trucks. It is only within the last two or three years that these vehicles have become an important factor in state highway traffic. The reason why they have so serious an effect on such roads is that they are operated in early spring and late fall when the roads are soft and easily cut up, whereas the touring car traffic which up to three years ago was the main traffic that gave the highway engineer concern did not become important on country roads until after the roads had dried out and settled in the spring. It is stated that in Massachusetts it will require hundreds of thousands of dollars to make good the damage done to the state highways within the past few weeks by heavy motor trucks and motor omnibuses, run over the roads just as the frost is coming out of the ground.

The problem highway engineers must face is the question how to maintain the roads under these conditions. It is evident from Mr. Ripley's review that the enormous cost of maintenance of New York state highways is due not alone to such extraordinary damage but to the unsystematic manner in which the work of maintenance has been carried on, up to two or three years ago.

It is of course an old story that the way to economically maintain a road surface is to take the "stitch in time that saves nine," and to keep the road continuously in good condition; but the advent of the automobile has accentuated the conditions that formerly prevailed, and made prompt and thorough maintenance absolutely essential, not merely to keep a road in good condition but to save it from being entirely destroyed.

It may be of interest in this connection to give some figures as to what New York has actually spent for the maintenance of some of its state roads, built within the last ten years. The Little Falls road in Herkimer County, 5⅓ mi. long, was built in 1906. The total cost, including grading, was $11,165 per mi., and during the six years from 1909 to 1914 inclusive, $7,294 per mi. was spent on it for maintenance and repairs. It is of interest to note that $4,940 per mi. was spent on this road in 1912, probably for the entire reconstruction of the surface. In 1913, however, $269 per mi. was spent upon it, and $562 in 1914. The New Lebanon-Brainard Road in Columbia County was built in 1907. Its length was 8 mi. and the cost of construction was $6,824 per mi. During the six years from 1909 to 1914, $3,928 per mi. was spent on it for maintenance and repairs, $1,702 per mi. was spent in 1913.

The Canton-Ogdensburg road in St. Lawrence County, built in 1908, is 7.9 mi. long, and cost $8,595 per mi. In the six years following, $3,270 per mi. was spent for maintenance and repairs. A road subjected to heavy travel between Troy and Schenectady, 3 mi. long, was built in 1907, at a cost of $11,782 per mi. In the six years from 1909 to 1914 $10,376 per mi. was spent on it for maintenance and repairs, of which $5,654 per mi. was spent in 1912, and over $1,000 per mi. in each of the two following years.

It is obvious that if any considerable part of the New York state highway system were to require a permanent annual charge per mile for maintenance such as these figures indicate, the burden on the taxpayers would be insupportable. As Mr. Ripley makes clear, however, a considerable part of the high cost of maintenance and repair has been due to the lack of system in maintenance. There are probably a good many miles of the state highway system which will eventually have to be rebuilt from the bottom up with a more permanent foundation to withstand the heavy traffic of the present day, but it is to be hoped that by the introduction of engineering methods in the work of maintenance, most of the roads now built may be kept in condition at a reasonable annual outlay.

That the life of wood-stave pipe depends upon the kind and grade of the wood used for the staves is well brought out by a letter printed elsewhere in this issue. The concluding sentence of the letter will bear repeating: "Fir and pine for strength, redwood for durability, should be as thoroughly understood as steel for strength and cast iron for durability." The letter also relates to the Seattle wood-stave conduits and the arguments recently advanced at Seattle for building a "concrete and steel conduit," besides containing a list of redwood stave-pipe lines installed from 1889 to 1908.

Letters to the Editor

Rating the Qualifications for Success in Engineering

Sir—I see no ground for objecting to the statement of qualities to be looked for in the young engineer as summarized by Prof. C. R. Mann from information received by him in response to an extensive inquiry. These as arranged by him are:

1. Character, integrity, responsibility, resourcefulness, initiative.
2. Judgment, commonsense, scientific attitude, perspective.
3. Efficiency, thoroughness, accuracy, industry.
4. Understanding of men, executive ability.
5. Knowledge of the fundamentals of engineering science.
6. Technique of practice and of business.

It is not so clear that this brief statement can be "used as a standard in developing organizations and curricula and in selecting efficient methods of instruction." There are several reasons for this:

1. The relative value of the several proposed units of measure is not the same; they cannot be marked off as a series of equal units or a single measuring stick, the total length of which will represent the whole man. It cannot be concluded that, because "technique" is sixth, all other qualities combined are five times as important.

2. The measures proposed are not and cannot be independent units; influences that are effective in developing any one cannot fail to produce effects on others. To be serviceable as a measure, the law of dependence should be defined. For example, it is my opinion that in developing technique, character also is developed. To what extent can I depend upon the training in technique as a means of securing character?

3. The school is not equally effective in making its impress upon the several qualities of which the proposed measure is composed. There are in fact some things that a school cannot do. The God-given qualities of a man count tremendously when one attempts to measure him. While we put character first and technique last in importance, when we attempt to measure the man, it would be wrong to assume that character should always be first and technique always last in the amount of attention bestowed by the school. It often happens that students enter school with more character than technique to their credit.

Professor Mann's circular letter is, I assume, to be accepted as an initial proposition, and as such it is extremely interesting. I have no doubt that in time he will disclose the next step in the development of a measure and of means whereby it may be made effective.

Urbana, Ill., Apr. 17, 1916. W. F. M. Goss.

Sir—With reference to the discussion on the qualifications requisite for a successful engineering career, it seems obvious to the writer that the considerations of "character" and "technique" are in nowise comparable, a point that seems to have been disregarded or overlooked in the previous discussion as well as in the preparation of the Mann "score-card." Plainly, if this be the case, two score-cards would be necessary—one for general and one for special qualifications. Under the former would be grouped such qualities as character, judgment and efficiency, giving proper percentage to each so as to make a total of 100%. These are qualities which any business man, be he lawyer, merchant, engineer or what not, would look for in a prospective employee or which would be necessary to a greater or less degree in the successful execution of a business enterprise. On the second score-card would be grouped such other qualities as have a bearing on the special work to be done, as, for an engineer, technical education, experience on similar work, and understanding of men.

A rough analogy may be drawn from the selection of a system of transportation. Suppose a contractor wants to carry a quantity of stone across a body of water. He will not look up the different makes of motor trucks for the simple reason that what he needs is a boat, although a motor truck is a fine transportation machine. Likewise a firm wishing to construct a machine shop will not consult a dentist, although the dentist may have a fine character and good all-round ability.

Furthermore, it seems inadvisable to assign a definite percentage to any one quality, as "efficiency 15%," for so broad a classification as to fit "a successful engineer," since so much depends upon the specific nature of the work to be done. Those qualifications which might make a man a fine bridge designer might not be at all adequate for a superintendent of construction. As a man progresses from one position to another he may make less and less use of his technical knowledge and find his understanding of men and his ability to organize and to hold in mind a general perspective of a large piece of work brought more and more into play.

The obvious conclusion is that no fixed rules can be followed, but that a careful analysis of each case is necessary to bring the right man to the right work.

R. D. Burdick,
Assistant Engineer, N. Y. C. & St. L. R.R.
Cleveland, Ohio, Apr. 24, 1916.

Sir—Referring to your editorial query, "Is Character the Fundamental Requisite for Engineers?" it is hard to understand how any other view could be taken than that character is the foundation stone upon which all the other qualifications must necessarily rest.

It does not matter how bright or how well educated an engineer is or how much past experience he has had, unless he can be trusted absolutely. Unless he is dependable, his other qualifications go for naught. If he is susceptible to dishonesty, he is practically of no value whatever to any client, because he cannot be trusted. "The sharper the blade the keener the cut." I might go on and enlarge along these lines, but I have said enough to have it understood why we must put character as a fundamental requisite for engineers. As to the other requisites, it is my impression that those who made up the list of the Mann "score-cards" had no in-

tention of conveying the impression that technical education should not have the proper consideration. What was in mind in assigning judgment—engineering judgment—was naturally the intention to convey the idea that engineering judgment is not the grocery man's judgment, but is a result of knowledge and experience in engineering. The grocery man who might have excellent judgment in the grocery business might have very poor judgment in the engineering business.

An engineer may be highly educated technically and yet lack the ability to work with men and obtain efficiency. We know of men who have had the greatest advantages technically and ought to rank high in the engineering world, but for the lack of these qualifications under consideration cannot be trusted with important work.

Pasadena, Calif., Apr. 26, 1916. C. W. KOINER.

Sir—Dean Marston's unique use of the Mann "score-card," as explained by him in your issue of Apr. 20, is peculiarly opportune.

If you grant for the sake of argument, first, that such a use of the card is justifiable and, second, that any significance is to be attached to such ratings of character as 78, 80, 93, etc., by any single observer, however competent, then two interesting questions arise: Is there any connection between the fact that the grocer, the merchant and the banker have a rating on character higher on the average by 5.7 points than that of the engineers and the fact that engineers are seldom chosen as members of public commissions, even when these deal with engineering works? If so, what is the meaning of this to the engineering schools and the engineering profession? W. A. STARRETT.

8 West 40th St., New York City, Apr. 29, 1916.

The Lower Otay Dam Failure

Sir—Your issue of Apr. 13 contains a letter from George Cromwell, City Engineer of San Diego, upon the failure of the Lower Otay dam, in which exception is taken to some remarks from the writer published in *Engineering News* of Mar. 9. Mr. Cromwell attempts to prove that my previous communication was based upon inaccurate data, claiming that all figures were obtained from textbooks, little attention being given to actual conditions.

The height of the dam, 130 ft., is first questioned, the City Engineer stating that the height was 135.5 ft. On p. 31, of the "Transactions" of the American Society of Civil Engineers, Vol. LXXV, the statement is made by Mr. O'Shaughnessy that the Lower Otay dam was completed to the 130-ft. level above the old stream bed on Aug. 18, 1897. Also *Engineering News* of Feb. 3, 1916, gave this dimension as 130 ft. However, in a matter of this kind the City Engineer ought to know, so the error is admitted, attention being called to the fact that the increased height made the structure more unsafe than the writer had previously assumed, and the risks involved in filling the reservoir were therefore greater.

Mr. Cromwell claims that this increased height of dam gave such additional capacity to the spillway that it should be considered in the analysis. The writer's investigation shows that the dam was weaker than the demands of good practice, before the water reached the floor of the spillway, so the capacity of this feature has no bearing whatever on my statement that the basin should not have been allowed to fill.

The slopes of the dam assumed are also questioned. As this matter seemed rather indefinite, computations were made on two slopes—1 : 1 and 1½ : 1. Even with the flatter slope the ratio between resisting force and applied load was much less than the demands of good practice, consequently there appears little meat in Mr. Cromwell's contention that as the slopes were 1¼ : 1, my data were inaccurate. Mr. Cromwell says:

> Third, the investigation relative to the coefficient against sliding, as Mr. Sellew calls it, does not seem to be to the point in view of the fact that the dam did not eventually fail by sliding upon its base.

In the design of dams it is necessary to oppose to the anticipated load a greater force—how much greater will depend upon local conditions and on the type of dam under consideration. With normal conditions a masonry dam will have an opposing force equal to twice the applied load and an earth dam about ten times. A rock-fill should lie between these two. An examination of several rock-fill dams shows the following ratios of the applied load to the opposing force, assuming a full reservoir:

Lower Otay with 1 : 1 slopes	1 : 1.85*
Lower Otay with 1½ : 1 slopes	1 : 2.60
Escondido	1 : 3.25
Castlewood	1 : 2.1
East Cañon Creek	1 : 4.0
Pecos River	1 : 3.35*
Walnut Grove	1 : 2.60*
Morena	1 : 4.90
Stanislau River	1 : 3.20
Bishop Creek	1 : 3.70
South Fork Stanislau River	1 : 5.00

Those marked * have failed. The writer makes no claim that the Lower Otay dam failed by sliding, but presents this table to indicate the relative stability when compared with other structures of its type and submits that the low ratio of the Otay was the source of its weakness, an appreciation of which should have suggested measures to prevent the filling of the reservoir. Mr. Cromwell's contention that the dam failed from overtopping is well answered by the editorial in *Engineering News* of Mar. 9, which shows that the amount of water passing over the top could have had little effect upon a rock-fill.

The City Engineer states that in his opinion the dam would have been standing today had not the water flowed over its top; that is, he believes that a ratio between load and opposing force of 1 : 1.85 is a safe one. It is hard to reconcile this opinion with the fact that after the failure at Otay some two billion gallons were wasted at Morena to lower the high-water line and this structure had a ratio of 1 : 4.90. If the Lower Otay was safe when full, there could be no valid reason for wasting at Morena a volume of water which at 10c. per thousand gallons (the price paid by the city to a private company) was worth $200,000.

A careful review of all the data obtainable convinces the writer that the Lower Otay dam failed because it did not contain sufficient material to resist a pressure due to a full reservoir; that this weakness was apparent from a comparison with other similar dams that had gone out and such weakness should have been known to those in charge of the works. While the dam was unsafe with a full reservoir, it had been of great service to the city when filled to lower levels, and had it been admin-

istered with prudence, San Diego would still be enjoying its benefits.

The discrepancies in design and construction were so apparent that there can be no excuse for the filling of this basin. But the city officials were so determined that this result should be accomplished that a rainmaker was hired to aid in the operation.

Under the conditions the writer is unable to accept Mr. Cromwell's invitation to retract former criticism and attribute the disaster to an act of God.

FRANCIS L. SELLEW.

La Jolla, Calif., April 24, 1916.

Pittsburgh Ruling on Flat-Slab Concrete-Floor Systems

Sir—There is appended hereto a copy of a ruling on four-way flat-slab construction in reinforced concrete which was adopted in the Bureau of Building Inspection of the City of Pittsburgh, Penn., while I was engineer of the bureau and which may be proposed as the requirement of the new building code of this city, if there are no serious objections to its form and meaning.

The ruling is intended to cover only the four-way systems. Other systems may be easily arranged for by introducing additional matter to cover such portions of the construction as are not covered in the ruling given. It is not intended to be a complete guide for the designer in his work, but as a very sure check to discover whether he has done his work correctly. The coefficients for the bending moments, which are the first point of investigation, were obtained by assuming the resisting section in the various tested buildings quoted in the accompanying table and calculating an equivalent uniform live-load from that one in the test which came closest to the assumed design load intended for the floor tested and then solving for the bending-moment coefficient in the usual way. The span used in each case was the clear distance between the edges of the column caps. This work was performed in the case of the direct bands as well as the diagonal ones and the results noted.

The divisor 16 for the positive moment in the center of the panel was selected because all the various forms of flat-slab construction are safe under this figure, even though the tests did not disclose stresses anywhere near those calculated by this method. But by this method the distribution of the steel in the diagonal bands must be properly arranged.

The great advantage of employing this method is that it is flexible. The design for the construction may vary according to the conditions of the loading and the span in a much more consistent manner than when the construction is limited by dimensions or proportions of the details. It allows to the designer the greatest latitude that is possibly consistent with safety of the construction and will invariably be found on trial to disclose to the investigator any error or deviation from the accepted test results which tends toward danger. If at first glance the reader thinks that the ruling is prohibitory, it will be best to reserve judgment until having given it a consistent trial. The principal result of its use is that the column cap is invariably made heavier than has been the practice in the past, but not so much as to be detrimental to the construction in any way.

The manner of dealing with rectangular panels will be easily understood and results in nothing different from the usual practice, which follows the theoretical laws for the variation in the bending moments in the case of two-dimension variations.

The formula for the resisting moment at the periphery of the drop construction is derived simply from the standard method of finding the bending moment at a certain section of a beam when the moment is known at another section and the shears between are to be multiplied by their acting arm in order to find the moment at the required section.

The ruling is not proposed as if completed, but in such an important matter as this it is best to have the light that may be shed upon it by those who may have had experiences which can show whether or not slight variations in the ruling would cause it to be of more correct or wider adaptability to the work on which it should be used. It is intended to bring out discussion of a constructive nature, as the writer is convinced that the method, when extended to cover the probable cases that may arise in its use, which can be found only by throwing upon it the light of careful scrutiny of the engineering profession, will be found to approach as near to the actual correct theoretical method as possible. It is only claimed to be based upon an empirical solution, but is not open to the usual objection that the constants used in the solution are not yet properly determined from a physical standpoint. Any such physical constants that may be considered will be found to have been accounted for in the fact that they affected the actual stresses in the tests and thus are actually accounted for in the formulas.

JOHN A. FERGUSON,
Secretary-Engineer of the Building Code Committee.

Pittsburgh, Penn., Apr. 25, 1916.

[The ruling and the table follow.—Editor.]

RULING ON THE DESIGN OF FLAT-SLAB CONSTRUCTION IN THE CITY OF PITTSBURGH

Definitions

1. Flat slabs, as understood by this ruling, shall consist of reinforced-concrete columns with enlarged capitals on which is supported a flat reinforced slab floor, with or without plates or depressed panels at the column cap. The construction may be such as to admit the use of hollow panels in the ceiling or smooth ceiling with depressed panel in the floor at the column cap.

COMPARISON OF STRESSES MEASURED IN EXTENSOMETER TESTS WITH STRESSES COMPUTED BY THE CHICAGO AND PITTSBURGH RULINGS.*

Building, City and Date of Test	Nature of Load	Loads in Lb. per Sq. Ft. Live	Dead	Total	Compression in Concrete at Edge of Column Capital: Actual Stress	Stress Computed by Chicago Ruling	Stress Computed by Pitts. Ruling	Tension in Steel Over Column Head: Actual Stress	Stress Computed by Chicago Ruling	Stress Computed by Pitts. Ruling	Tension in Steel at Center of Span: Actual Stress	Stress Computed by Chicago Ruling	Stress Computed by Pitts. Ruling
Deere & Webber	Design	225	115	340	750	750	780	16,000	28,600	19,000	4,000	14,700	11,300
Minneapolis, 1910	Test	350	115	465	1,000	1,030	1,150	24,000	39,200	26,000	7,000	20,200	15,400
Franks	Design	256	115	371	680	700	750	4,000	11,200	7,500	4,500	15,000	11,400
Chicago, 1911	Test	624	115	739	1,390	1,400	1,500	8,700	22,400	15,000	10,100	30,000	22,800
Larkin	Design	250	120	370	450	560	650	3,000	18,000	10,200	3,300	18,000	14,000
Chicago, 1912	Test	618	120	738	1,000	1,120	1,300	8,500	36,000	20,400	16,000	36,000	28,000
Excelsior	Design	150	125	275	350	580	600	3,500	16,200	9,950	2,600	20,500	15,700
Chicago, 1914	Test	425	125	550	720	1,160	1,200	12,100	32,400	19,900	15,000	41,000	31,400

* Table calculated by A. R. Lord.

2. The column capital shall be defined as the gradual flaring out of the column without any marked offset in the concrete.

3. The depressed panel shall be defined as a square, rectangular or approximately circular depression around the column capital extending below the adjacent slab.

4. The panel length shall be defined as the distance center to center of column of the side of a square panel, and the panel length and breadth of a rectangular panel as the distance center to center of column in the long and short directions respectively. The span length is defined as the distance in the clear from edge to edge of column cap where it intersects either the floor slab or the depressed panel, measured on the length or breadth of the panel as the case may be.

Stresses

5. All unit stresses shall be as specified in the general ordinance on the "Use of Concrete and Reinforced Concrete." Stresses shall be computed under the assumption set forth in that ordinance.

Moments

6. The negative bending moment at the support shall be taken $\frac{W' L'}{11}$, in which W' equals the total load on one panel exclusive of any load within the area of the column capital and L' is the clear span between column capitals measured along the side of the panel.

7. The positive moment at the center of the panel shall be taken as $\frac{W L}{16}$, in which W is the total load on a panel and L the distance center to center of columns measured along the side of the panel.

Resisting Sections

8. The negative moment at the support shall be considered as acting on a vertical section passing through the slab along the periphery of the column capital. The compressive stress in the concrete on this section shall be figured by the ordinary straight-line assumptions of stress distribution taking the periphery of the column capital as the width of the section and the depth from the lower face of the concrete adjoining the column capital to the center of gravity of the slab steel as the depth of the section.

9. The area of slab steel resisting the negative moment of $\frac{W' L'}{11}$ at the support shall be taken as the total section of all slab rods cutting a conical critical section starting at the periphery of the column capital and flaring outward at a 45° angle with the vertical. The spacing of rods thus determined for the width of the critical section shall be maintained for the full width of the bands.

10. The positive moment at the center shall be resisted by the steel and concrete cut by a vertical critical section through the slab having its center at the column center and its diameter equal to the mean dimension of the sides of the panel.

Drop Construction

11. The thickness of the slab adjacent to the column capital may be increased, if necessary, by means of a depressed concrete drop panel centered on the column center. Where this depressed panel is used, the resisting moment of the slag at the periphery of the depression shall be not less than that figured from the formula $M = W' \left(\frac{L'}{11} + \frac{X^2}{L'} - \frac{X}{2}\right)$, in which W' and L' are as defined above and X is the distance between the edge of the column capital and a circle of area equal to that of the drop used. This depressed panel may be diminished in thickness at greater distance from the column capital if desired, provided the resisting moment at any section shall not fall below the value determined by the above formula applied to that particular section.

Columns

12. The columns shall be figured for the unbalanced moment of the live floor load when the entire area on one side of a line through the column center is considered as loaded and the area on the other side unloaded. The live-load reaction producing this moment shall be considered as uniformly distributed along the periphery of the column capital.

Distribution of Slab Steel

13. The computed area of steel per unit width of band determined from the moment at the support shall be maintained the same for the entire width of each band. Width of bands shall not be less than four-tenths of the direct span between column centers. The total steel area as determined from the computations may be distributed equally between all the bands or somewhat more than one-half may be placed in the direct bands. In no case, however, shall the steel area of direct bands exceed that in diagonal bands by more than one-third (for square panels).

Rectangular Panels

14. The slab thickness and the steel area in the diagonal bands shall be determined in rectangular panels by computations based on a square panel of the same average dimensions. The steel area in the long direct bands shall be that required in the same band if situated on the edge of a square panel of the long dimensions in size. The steel area in the short direct band shall be that required in the same band if situated on the edge of a square panel of the short dimensions in size.

Profile of the Column Capital

15. The profile of the column capital shall satisfy the moment of $\frac{W' L'}{11}$ at any concentric vertical section through it and the slab, the value of W' and L' being taken for the particular section considered.

Moments in Wall Panels

16. The bending moment to be resisted by any band of reinforcing extending into an exterior panel shall be increased by 20% if concrete column supports are present at the wall and by 40% if the slab rests on a bearing wall at its exterior edge.

Concentrated Loads

17. Girders and beams shall be provided where necessary to carry concentrated loads in excess of the safe capacity of the floor slab. Such girders and beams shall be calculated for the full concentrated load.

Note—The unit stresses permitted in the ordinance on reinforced concrete above referred to are as follows:

	Lb. per Sq. In.
Compression in extreme fiber	650
Tension for steel in beams	16,000
Bond of concrete to steel	80
Shear in concrete unaccompanied by tension	120
Allowed tensile strain in concrete, diagonal, in beams	90
Tensile strain allowed in diagonal tensile stress	1,350

Status of Activated Sludge

Sir—In my article on the "Status of Activated-Sludge Sewage Treatment," published in the *Engineering News* of Apr. 27, 1916, there is a typographical error which affects the meaning and intent of the writer. On page 800, beginning at the 7th line from the top of the page, it is stated:

> As a preliminary to activation, the screen should not be too fine. An aperture less than ½ in. would probably remove material that should be activated, while larger than $\frac{3}{16}$ in. would admit substances that should be treated as screenings.

The first of these figures should have read $\frac{1}{32}$ instead of ½ in. The writer had in mind the Riensch-Wurl screen at Cleveland, which has $\frac{1}{32}$-in. apertures, as the finest permissible for use in this connection; while a screen of the same kind with $\frac{3}{16}$-in. aperture seemed the other limit.

GEORGE T. HAMMOND.

215 Montague St., Brooklyn, N. Y., Apr. 29, 1916.

Wood-Stave Water Conduits

Sir—I have read with great interest the article by Charles Evan Fowler, entitled "Seattle Water-Works Troubles," published in *Engineering News*, Mar. 30, 1916. Of especial interest was the reference to the cost of the main supply pipe. Since recent publications have given considerable publicity to these pipes, a discussion of their merits may not be amiss.

It seems that when these lines were contemplated a study was made of the respective merits of wood-stave and steel pipe, with the ultimate result that the wood-stave pipe showed a saving in cost over a period of 45 yr. of $1,413,756. Consistent with economy, as would be expected, wood-stave pipe was chosen.

Any pipe line, whether built of steel, wood staves or steel and concrete, should be protected against injury from outside causes. The pipe should be buried if exposed to danger from land slides or falling boulders; trestles or bridges should be located and designed with a view to protection from floods; air valves should

be of sufficient size and number to care for the relieving of vacuum or negative pressure created by sudden outflow of water in the pipe due to a break in the line or sudden opening of gate valves; and finally the design should provide an ample factor of safety against such overload as may arise from water-hammer, etc. With such precautions assumed, the merits of an economical installation depend upon total cost, including first cost, maintenance, depreciation and interest on the investment, and involve therefore the life of the pipe.

In designing the Seattle conduits wood-stave pipe was given a length of life equal to the usual assumed life of steel pipe, or 15 yr. I understand that concrete-and-steel construction was disregarded because its cost would have exceeded the amount of money available at that time. The matter then evolved into relative first cost, maintenance and interest on investment pertaining to steel and wood-stave pipe, the result being in favor of the wood stave. Assuming that all precautions for the protection of the line had been taken and maintained, there should not now be any question of the correctness of the judgment of the engineers in charge of the work in choosing wood-stave pipe.

However, there is one point that was overlooked or disregarded at the time of installation. This oversight is still a common one among engineers, and it occurs in the classification of wood-stave pipe as a whole, irrespective of the material from which it is made.

With wood-stave pipe of California redwood a cheap pipe is secured with a life that approaches permanent construction. Properly constructed pipe made of clear, air-dried redwood staves will give a life approaching that of cast iron; and while the first cost will be higher than that of treated fir or pine pipe, it will be less than that of steel, while the annual cost or sinking fund necessary to cover its renewal will be but a fraction of the corresponding reserve necessary to be considered in installing fir-stave or steel pipe.

The wood-stave pipe in Seattle (fir-stave pipe) was given as its maximum life 15 yr., the estimated life of steel pipe. The cost over a period of 45 yr. was figured to be $1,947,595—a saving of $1,413,756 over and above the cost of steel pipe for the same period. This included the first cost of the wood pipe ($322,952) and two renewals at a cost of $311,294, interest figured at 5%. Over 45 yr. this gave an average annual expenditure of approximately $43,280.

A wood-stave pipe, if made of redwood, would cost approximately 33⅓% more than the fir pipe, or $430,600. Assume a cost of $500,000 for the redwood-stave pipe. The life of a properly constructed pipe made of staves of the best quality of clear, air-dried redwood could be safely placed at 50 yr., while a longer life is probable. The approximate annual cost would be, on this basis, $10,000—an annual saving on this conservative estimate of $33,280.

A clearer comparison would be shown by assuming that the revenue derived from the sale of water would clear off the first cost of the fir pipe in 15 yr. This would leave two renewals at $311,294 each to be cared for in the following 30 yr., figuring that a concrete-steel pipe would be in operation replacing these lines at the end of that time. If redwood pipe were used, the first cost of $500,000 would at the same rate be paid off in 23 yr., the pipe for the remaining 22 yr. costing the city nothing.

A great many redwood-stave pipes have been installed throughout this country and other countries during the past 30 yr., and investigation has revealed them to be still in excellent condition, good for many more years of service. An assumed life of 50 or more years is readily admitted by those who are familiar with this type of pipe construction.

Some wood-pipe lines built with redwood staves, with dates of installation, are given in the accompanying table. Any of these lines can be personally investigated by engineers desiring data in order to be convinced of the merit of redwood.

It is not necessary to go to the expense of a cast-iron or concrete-steel pipe to secure a pipe that will give continued service over a long period of years. To renew

SOME REDWOOD-STAVE PIPE LINES INSTALLED FROM 1889 TO 1908

Installed	Owner	Location	Diameter. In.
1889	City of Ogden	Provo, Utah	14
1891	City of Provo	Ogden, Ariz.	18
1892	City of Logan	Logan, Utah	18
1892	City of Yuma	Yuma, Ariz.	26
1892	Butte City Water Co.	Butte, Mont.	24
1899	Butte City Water Co.	Butte, Mont.	26
1893	Kern County Land Co.	Bakersfield, Calif.	72
1893	Mt. Nebo Land Co.	Mt. Nebo, Calif.	48
1894	Oakland Water Co.	Oakland, Calif.	20
1895	William Inayes	Montpelier, Idaho	24
1897	North Star Mines Co.	Grass Valley, Calif.	14
1898	City of Palto Alto*	Palo Alto, Calif.	12
1899	Yuba Electric Co.	Marysville, Calif.	36
1899	Floriston Pulp and Paper Co.	Floriston, Calif.	108
1900	Reno Light and Power Co.	Reno, Nev.	48
1900	Honolulu Plantation Co.	Honolulu, T. H.	24
1900	Kihei Plantation Co.	Hawaiian Islands	24
1900	Moonlight Water Co.	Nome, Alaska	14
1901	Hawaiian Sugar Co.	Mauli, T. H.	24
1901	Southern California Mountain Water Co.	San Diego, Calif.	24
1901	Anaconda Copper Co.	Anaconda, Mont.	66
1902	Melones Mining Co.	Melones, Calif.	72
1902	Los Alamitos Sugar Co.	Los Alamitos, Calif.	18
1903	Utah Sugar Co.	Garland, Utah	24
1903	Vancouver Power Co.	Vancouver, B. C.	54
1903	Idaho Sugar Co.	Idaho Falls, Idaho	24
1904	Cornell University	Ithaca, N. Y.	60
1904	Idaho Construction and Power Co.	Idaho Falls, Idaho	120
1904	City of Lynchburg	Lynchburg, Va.	30
1905	Great Northern Power Co.†	Duluth, Minn.	84
1905	City of Greensboro	Greensboro, N. C.	24
1905	Cerro de Pasco Mining Co.	La Fundicion, Peru	22
1905	City of St. John	St. John, N. B.	33
1905	City of Dallas	Dallas, Tex.	42
1906	Guanajuato Power Co.	Zamora, Mexico	69
1906	Mill Creek Power Co.	Salt Lake City	22
1906	Garfield Water Co.	Garfield, Utah	141
1906	Utah Copper Co.	Bingham, Utah	24
1907	North Fork Ditch Co.	Folsom, Calif.	52
1908	City of Temple	Temple, Tex.	18
1908	French Land and Irrigation Co.	French, N. M.	42

*Sewer pipe; no pressure; laid in salt marsh. †Four parallel lines.

pipe lines every 15 yr. when 30% additional expenditure at first would more than double the life would seem poor engineering and economy. A thorough, economical study of available material for a pipe line should be given more careful consideration by all engineers. Just as the quality of cast iron and steel is known to vary, so should the quality of various kinds of lumber for different uses be appreciated. Fir and pine for strength, redwood for durability, should be as thoroughly understood as steel for strength and cast iron for durability.

JOHN F. PARTRIDGE.

Hobart Building, San Francisco, Calif., Apr. 8, 1916.

NOTES AND QUERIES

The Diagonal Station Drawing reproduced as Fig. 5 of D. A. Sealey's article on "Rapid-Transit Work in 1915, New York City," p. 846, May 4, 1916, was unfortunately not credited to its author. The original was drawn by George Perrine, Assistant Engineer, Rapid Transit Subway Construction Co., and was distributed to a visiting party of the American Society of Civil Engineers last January.

Grease and Fertilizer Base from Boston Sewage*

By Robert Spurr Weston†

Experiments to determine the feasibility of a new process of sewage treatment invented and patented by George W. Miles, a Boston chemist, were made from 1911 to 1914 under the direction of E. S. Dorr, of the Boston Sewer Department, with results that seem to indicate that it will be not only successful, but profitable. The process may be described as follows:

Ordinary sewage sludge from settling basins is greasy, offensive and of so little practical value that farmers will not accept it for fertilizer, even as a gift, yet sewage sludge contains fertilizing elements of great value and considerable grease. The Miles process attempts by the addition of an acid to precipitate the bulk of the solids from sewage in the form of a sludge that can be dried and degreased, thereby producing a readily salable and greaseless fertilizer, as well as recovering the valuable grease. Either sulphuric acid or sulphurous acid may be used, and the process contemplates the manufacture of the acid at the disposal works. If sulphuric acid were chosen, ordinary weak chamber acid of 1.53 specific gravity would be used, but the cheapest source of acid is undoubtedly pyrite (native FeS_2), which when roasted in a furnace of proper construction produces sulphur dioxide (SO_2). This is a gas that may be fed directly into the sewage, in which it would dissolve, forming sulphurous acid.

The addition of sulphur dioxide precipitates most of the grease, together with the greater part of the suspended matter. The resulting sludge is dried, extracted with a solvent to recover the grease, and the remainder prepared for fertilizer. An important sanitary feature of the treatment is that the sulphur dioxide is a strong disinfectant, so that the acidified sewage contains few bacteria. It also contains but little suspended matter. Consequently, the supernatant liquid may be discharged into a body of water like Boston Harbor without producing any nuisance.

The experiments, which were conducted by officers of the sewer division of the City of Boston, consisted of 11 runs, involving the treatment of about 26,000 gal. of sewage. From these experiments it was concluded that from 1,000,000 gal. of sewage 1,738 lb. of dried sludge would be obtained and that it would contain 21.7% of grease, which at 4c. a pound would yield $15.08. In addition, there would be 13.61 lb. of fertilizer base, estimated according to agricultural standards to be worth $9.25, making the total value of the recoverable material about $24.33 per 1,000,000 gal.

The results of Mr. Dorr's experiments were so promising that their repetition under the supervision of impartial investigators and for a longer period was thought worth while, and arrangements were made for a week's study of the process under the supervision of the sanitary-research laboratory of the Massachusetts Institute of Technology. These further experiments were begun on July 7, 1915, and were made under the direction of Robert Spurr Weston, with Prof. W. T. Sedgwick in consultation. The results obtained were checked by further experiments, covering three days, which began on Nov. 8, 1915, so that the tests covered both warm- and cold-weather conditions. The close agreement between the results of the two sets of experiments is remarkable, and it may be definitely stated that the experiments of the sanitary-research laboratory confirm the results obtained by Mr. Dorr regarding the amount of sludge that may be recovered from Boston sewage and the amount of grease that is present therein. The Miles acid process has thus been shown to possess many advantages as a method of sewage disposal for cities like Boston, namely:

1. It disinfects the sewage by reducing the numbers of bacteria from millions to hundreds per cubic centimeter.

2. If the drying of the sludge and the extraction of the grease can be accomplished economically, it is probable that a large part, if not all, of the cost of the acid treatment may be met by the sale of the grease and fertilizer recovered from the sewage.

3. The use of so strong a deodorizer and disinfectant as sulphur dioxide would prevent the usual nuisance of treatment works. The experiments have shown that the sludge can be held at the works for four days during the heated season without giving off offensive odors, while the effluent is inoffensive and stable enough to be discharged into Boston Harbor without the slightest probability of creating a nuisance.

4. The addition of sulphur dioxide to the sewage also avoids any fly nuisance, which is a handicap to the operation of Imhoff tanks and trickling filters. This fact, with the absence of odor, would be a great advantage to any plant located at Moon Island and would probably cause a great appreciation in value of the surrounding property.

Drying of the sludge and the extraction of the grease are absolutely essential for the success of the process. Mr. Dorr's figures, which show profits of from $6 to $11 per 1,000,000 gal., appear high, and it is possible that he has allowed too little for the acid and for the cost of drying the sludge; but even if his figures be doubled, the process is still well worthy of consideration by the City of Boston, because of its freedom from nuisance, as it produces an effluent which is practically free from disease germs and which can be discharged into the harbor with impunity.

With the facts at hand, the process would be very satisfactory for Boston from a sanitary standpoint and is more promising economically than any other known. The value of Imhoff tank sludge is hardly enough to pay for the drying; at Milwaukee, Chief Engineer Hatton estimates the total value of activated sludge at from $9 to $15 per 1,000,000 gal., while our Boston experiments have proved that the sludge from the Miles process, although less in bulk than that from the activated-sludge process, has a value of more than $24 per 1,000,000 gal. of sewage. Correcting Mr. Dorr's estimates for the higher amounts of acid which these experiments show to be necessary, one gets $18 per 1,000,000 gal. as the average cost of treatment, and $6 as the margin of profit. While it is believed that this estimated margin of profit is too high, the writer is unable, by any reasonable comparison with analagous cost data from other sources, including his experience, to wipe it out. Furthermore, the size of the Moon Island plant and the tanks already in existence there are all in favor of a reduced rather than an increased cost of treatment.

*Abstract of a paper in the "Journal" of the American Public Health Association, April, 1916.

†Consulting Sanitary Engineer, 14 Beacon St., Boston, Mass.

News of the Engineering World

Parkersburg Suspension Bridge Opened to Traffic

A new highway crossing of the Ohio River was put into service Apr. 29 with the formal opening to traffic of the suspension bridge between Parkersburg, W. Va., and Belpre, Ohio. The bridge, located 280 ft. below the Baltimore & Ohio R.R. crossing, has two electric-railway tracks in a roadway of 22 ft. clear width and one 6-ft. sidewalk. The design contemplates the use of interurban cars weighing 50 tons each, a live-load of 100 lb. per sq.ft. of roadway and a 16-ton road roller for maximum floor concentrations.

The total length of the bridge is 2,856 ft., comprising 700 ft. of viaduct approach at the Parkersburg end, a 200-ft. through-truss span, three suspension spans—375, 775 and 275 ft. in length—and 500 ft. of approach at the Belpre end. The approaches are plate girders, 40 to 117 ft. in span. A required clearance of 90 ft. above low water for the main-channel span, together with rather low banks, necessitated the use of 5¼% grades for the approaches; elsewhere 2% grades are used, except for the Belpre side span, which is on a 4% grade.

Two of the river piers are founded on rock, 16 ft. below the bed of the river. The other pier and the Parkersburg anchorage rest on piling, and the Belpre anchorage on sandy clay. There are 13,000 cu.yd. of concrete in the substructure.

Each of the cables has an area of 40.8 sq.in. net section and contains seven strands of No. 8 wire. The ultimate strength of the wire is 230,000 lb. per sq.in., the elastic limit about 150,000 lb. per sq.in. and the working stress 50,000 lb. per sq.in. under full load. After the erection of the towers by floating derrick and gin pole a temporary cable was strung from anchorage to anchorage over the position of each main cable. Each strand of the main cables was built up on shore, special precautions being taken to insure that the wires would take uniform tension in service. The strands were then hauled across the river with the aid of the temporary cables, from which they were slung. When in proper position, they were placed in the cast-steel clamps at the tops of towers, rocker bent and attached to the anchorage eye-bars. Men working in erection cages suspended from the cables placed temporary clamps to hold the strands in proper relative position. The cables were then wrapped, using a rig very similar to that employed for the same purpose on the East River bridges. Lastly, the hanger rods were attached by cast-steel clamps and the erection of the floor system started.

Steel was brought out on barges and erection carried both ways from each tower, using light jinnywink der-

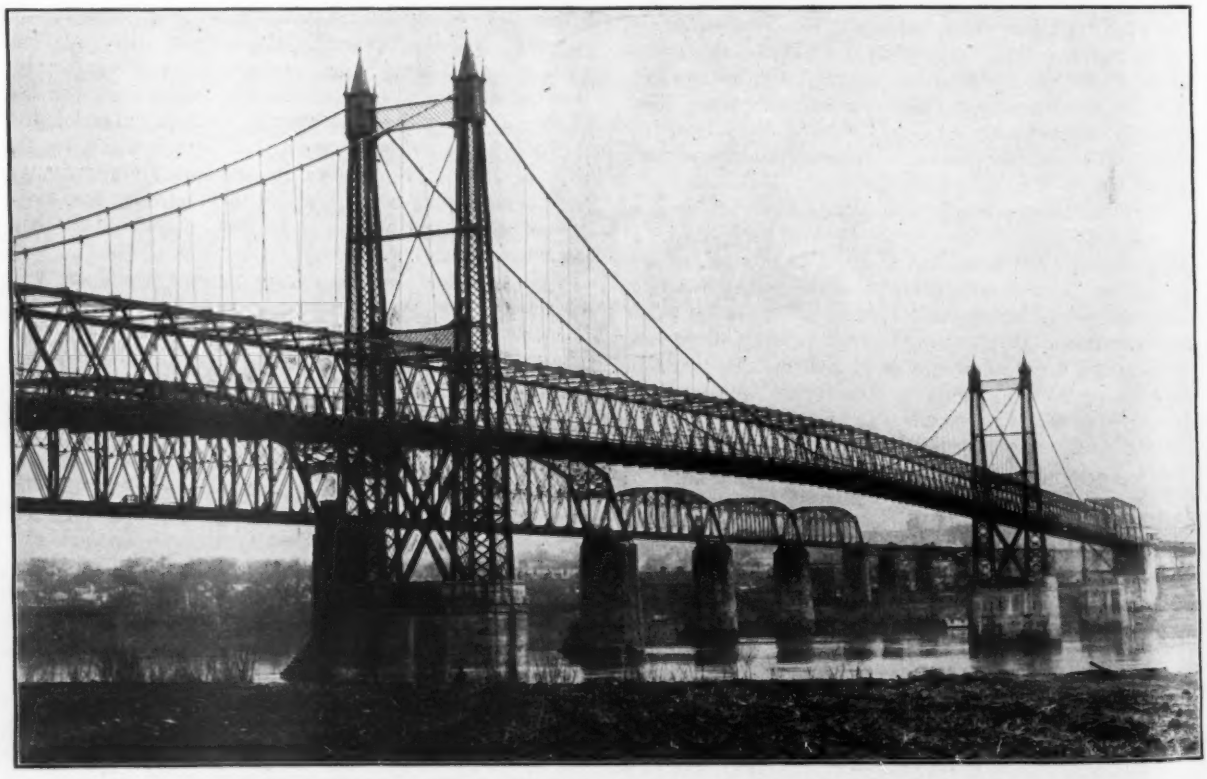


FIG. 1. NEW HIGHWAY BRIDGE ACROSS OHIO RIVER AT PARKERSBURG, W. VA.

FIG. 2. ROADWAY OF PARKERSBURG BRIDGE

ricks. The floor system, consisting of four lines of track stringers and one line of sidewalk stringers, with lateral bracing, was practically completed before any work was done on the stiffening trusses. The steel for these was strung out along the floor to give approximately the proper dead-load profile to the bridge and was then placed by the same jinnywinks.

The stiffening trusses are 21 ft. deep and spaced 24 ft. apart c. to c. They have box chords and double-angle diagonals. Rocker-bearing expansion joints for the stiffening trusses occur at the towers; the outer ends are fixed. There is a sliding joint at the center of the upper chord of the main-channel span, while the bottom chord of the span is continuous throughout. The three middle floor-beams are fixed to the cables so as to divide the expansion equally between the two halves of the span. Where the cables intersect the top chords of the stiffening trusses, special wind struts are provided, and there is a top and bottom lateral system of angles.

The two main towers are composed each of eight open columns, braced in fours to form two pedestals, and anchored well down in the pier.

The decking of the 200-ft. span and the suspension spans is of long-leaf yellow pine treated in hot Carbolineum Avenarius. The approach spans have a reinforced-concrete floor and sidewalk and are brick paved.

The bridge cost $440,000, including right-of-way, and took 13 months to build. The owner is the Parkersburg-Ohio Bridge Co., Hermann Laub, Consulting Engineer; R. C. Venable, Supervising Engineer; and L. W. Jacobs, Resident Engineer. Laub & Stuart had the general contract. Substructure work was done by the Dravo Contracting Co.; the steel was fabricated by the American Bridge Co. and erected by Pittsburgh Construction Co.

"War-Engineering Applied to Man-Slaughter"

"Engineering applied to man-slaughter" was Col. F. R. Shunk's definition of modern war at the first lecture (May 3) on military engineering in the series arranged for the technical men of the Pittsburgh district by the Engineers' Society of Western Pennsylvania. There were 1,500 men at the lecture in the Carnegie Institute auditorium. Colonel Shunk's topic was "Organization and Duties of Engineer Troops," and he showed the meagerness of the present corps and how it would have to be expanded in time of war.

In connection with Isham Randolph's suggestion that civil works be taken from the Army Engineer Corps, Colonel Shunk cited the military work that is now impossible—such as making detailed military maps on a scale of 12 in. to the mile. He had hoped, when first detailed to the important district of Pittsburgh, to be able to squeeze in the mapping of the surrounding country, but it had been impossible. He mentioned, however, the advantages of the training given the Army Engineers by the civil works—knowledge of construction methods, business dealings and handling of men without autocratic authority.

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Federal Legislation Likely for Flood Control

The Humphreys bill, providing for Federal action to control the floods of the Mississippi River, was favorably reported to the House of Representatives on Apr. 29 by the newly created Committee on Flood Control. The bill authorizes the Secretary of War to spend not more than $45,000,000, either by contract or by day's work, in carrying out the plans of the Mississippi River Commission for the regulation of the Mississippi, not more than $10,000,000 of this amount to be spent during any one fiscal year. Appropriations for the work are to be made in the Sundry Civil bill. The money is to be expended between the Head of the Passes below New Orleans and the mouth of the Ohio River. This means of course that the money is to be expended in levee construction and bank revetments. Where money is spent on levee construction the local interests affected must contribute at least one-third the cost of the work and free right-of-way must be provided.

The bill further provides that not more than $5,600,000 may be spent for flood control on the Sacramento River in California, at the rate of not more than $1,000,000 per year, with the provision that the state must contribute to the work an amount at least equal to the Federal expenditure.

The third section of the bill provides that the Corps of Engineers, under direction of the Secretary of War, will have charge of all expenditures for flood control under the provisions of this bill and may make investigations and reports on works for flood control on other rivers. In making such investigations, the report is to show the extent and character of the area benefited by the proposed improvement, the effect upon any navigable waterway, the possible development of water power, and any other benefits which may result from the project.

The Committee on Flood Control is a special committee created by the House on Feb. 3. The committee

took a trip down the Mississippi from Cairo to New Orleans during the February flood and favorably reported the bill to the House on Apr. 29, only eleven days after its introduction. The bill was considered by the House in committee of the whole on May 3 and the sentiments expressed in the debate indicate its probable passage at an early day. It is reported that the Senate also is likely to give it favorable consideration.

Federal Aid Road Bill Passes United States Senate

The Bankhead bill for Federal aid to state road construction passed the Senate on May 8. The bill appropriates $5,000,000 for the year ending June 30, 1917; $10,000,000 for the year following and further increases of $5,000,000 each year until 1921, when $25,000,000 will be available. The appropriation is to be apportioned to the different states by the Secretary of Agriculture, one-third in the ratio of the area of the state to the total area of the country, one-third in the ratio of the population in the state to the total population, and one-third in the ratio of the mileage of rural delivery routes of the state to the total mileage of the country. In addition, the bill appropriates $1,000,000 annually, beginning with the year ending June 30, 1917, for "the survey, construction and maintenance of roads and trails within or partly within the national forests, when necessary for the use and development of resources on which communities in and near the national forests are dependent." The bill as passed by the Senate is a substitute for the Shackleford bill which the House passed early in the session, which appropriated $25,000,000 for Federal aid.

Federal Trade Commission for Export Trade Co-operation

The Federal Trade Commission announces the result of an extended investigation of competitive conditions in international trade. It finds that America is handicapped in its export trade by the superior organization of foreign manufacturers and exporters. It urges on Congress immediate legislation permitting combination and coöperation among American firms in the conduct of export trade. While at the present time the United States is enjoying an enormous and unprecedented trade with other nations, a large part of this trade is due to war conditions, and much of it is being done on terms and by methods which are alienating the purchasers and will insure the reversion of their trade to other countries at the first opportunity.

The foreign nations with whom we must compete have built up their ocean shipping, granted low export railway rates and established foreign trade banks, all of which operate together to give the foreign exporter an advantage over his American competitor.

Reviewing the foreign combinations which compete with American exporters, the commission says that there were in Germany prior to the war 600 important cartels or combinations to control prices, embracing practically every industry in the Empire. For example, two great companies which work in harmony with each other, the Algemeine Electricitats and the Siemens-Shuckert, control the bulk of the manufacture and export of electrical equipment. Half of the $150,000,000 worth of coal and coke exported is handled by the great Rhenish Westphalian Coal Syndicate, a combination of coal producers of which the government-owned mines are members. Practically all of the iron and steel export business in Germany is handled by a single sales agency, the Stahlwerks Verband.

An organization of Japanese textile manufacturers is rapidly obtaining the rich cotton goods trade of North China. In Great Britain, a large part of the export business is done by individual firms, relying upon their long experience and established reputation. Nevertheless in many industries associations of manufacturers have been formed to handle the export trade.

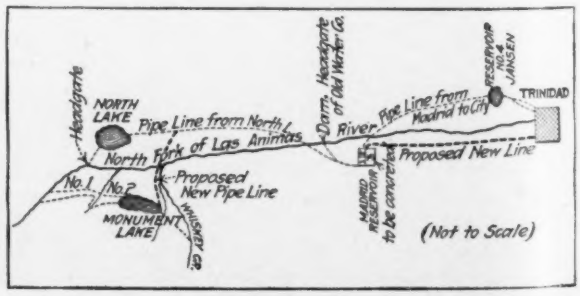
Besides foreign combinations of foreign firms in the export trade, other combinations limit competition in the purchase of American goods. A combination of British coal brokers fixes the price for bunkering ships at Newport News.

The commission recognizes the danger that coöperative export organizations of American manufacturers might attempt to control prices in the home market as well and also that such combinations might be used to the injury of the individual American exporter. The commission recommends that these dangers be met by an extension of the law prohibiting unfair methods of competition in export trade and by the enforcement of the anti-trust laws in connection with domestic trade.

Water-Supply Improvements, Trinidad, Colo.

The City of Trinidad, Colo., the center of the state's coal-mining activities, has a municipal water-supply in the mountains above the city. The collecting reservoirs are natural lakes about 27 mi. from the city. Water from the mountain creeks forming the North Fork of the Las Animas River is conducted to these reservoirs by a system of pipes and open ditches. Only one of these lakes, known as North Lake, has been fully developed as yet.

The city has just begun the expenditure of $185,000 for improvements and additions. Water from North Lake is now conducted by a single main to the Madrid reservoir, about 8 mi. from the city; from here a single main carries the water through another reservoir to the city mains. The improvements under way include a new 24-in. wood-stave main from the Madrid reservoir to the city by a new route and the lining of the Madrid reservoir with concrete. Ultimately the other lake, known



SKETCH PLAN OF WATER-SUPPLY OF TRINIDAD, COLO., SHOWING CONTEMPLATED IMPROVEMENTS

as Monument Lake, will be connected with the present main between North Lake and the Madrid reservoir.

The Madrid reservoir lies over a coal seam and leaks badly. It is divided into three compartments or basins—one of 80,000,000 gal. and two of 10,000,000 gal. capacity each. These are to be completely lined with concrete slabs. The work is to be done by day labor under the supervision of M. R. Lewis, Chief Engineer of the Trinidad water-works.

New Potomac River Bridge

A recent act of Congress, unless vetoed by the President, assures the construction of a new bridge across the Potomac River at Washington to replace the old Aqueduct bridge at the north end of the city. The Aqueduct bridge, crossing between 36th St. in Georgetown, D. C., and Virginia, was built 80 years ago to carry the Chesapeake & Ohio canal across the river on its way to Alexandria. The original structure was a series of wooden arches on cut-stone piers and was built between 1835 and 1840. In 1887, the aqueduct having been removed, the wooden arches were replaced by an iron highway bridge of nine Pratt truss deck spans, each 114 ft. long, and one through span, all on the old piers. For many years there has been trouble with the foundations of these piers, which were being undermined by high and swift water, and several difficult and expensive repair operations had to be undertaken (see *Engineering News*, July 26, 1900, p. 54).

The bridge for some time has been in an unsatisfactory condition, particularly as the traffic over it has increased at a great rate during the past ten years. The new bridge is to be built by the Federal Government at an adjacent site. It will make the third bridge across the main branch of the Potomac at Washington, the other two being the Highway bridge, replacing the old Long bridge, and the immediately adjacent Southern Ry. bridge. A fourth bridge, projected but never authorized, is the Memorial bridge between the Mall and Arlington, for which prize designs were accepted some years ago.

The new Aqueduct bridge is to be built by the Corps of Engineers, U. S. A., but will be maintained by the District of Columbia. A sum of $1,000,000 has been appropriated for the bridge and $150,000 for preparation of plans.

Cause of the New York Central Wreck at Amherst, Ohio, on Mar. 29, described in "Engineering News" of Apr. 6, was found by the Interstate Commerce Commission and the Ohio State Utilities Commission to be the inattention of Engineman Hess, who was on the second section of train 86 which ran into the rear of the first section, the wreckage of both being plowed through by the Twentieth Century Limited, running on an adjoining track. The report states:

We believe that the engineman of second 86 failed to observe the caution indications at signal S9-2 and the stop indication at signal S7-2 (first and second signals, respectively, west of the point of collision), and that this was the direct cause of the accident.

Steel Trestle Bent Fell—One man was killed, two others were severely injured and a fourth escaped by jumping when a bent of a steel trestle which was being dismantled on the Bessemer & Lake Erie R.R., near Tarentum, Penn., toppled over. The girder span supported by the bent had been removed and the men were ready to make fast the main falls of the derrick car so as to lift up the bent and lower it to the ground. The bent was guyed with temporary lines, but became overbalanced and tore loose from the guys. The man who was killed was working at the top of the bent and fell the entire 90 ft. and was crushed. The one who escaped showed remarkable coolness and presence of mind by crawling from the lower to the upper side of the steelwork as it started to go, and then jumping as it neared the ground. He landed uninjured in a piece of swampy ground.

A Terminal Warehouse and Docks at Bayonne, N. J., are under consideration by Irving T. Bush, the founder and president of the well-known Bush Terminals at Brooklyn, N. Y. It is reported that Mr. Bush has agreed to construct a $20,000,000 plant, similar to that at Brooklyn, on the New York Bay shore of Bayonne, provided property and franchise rights can be arranged.

The Marseilles-Rhone Canal Tunnel, described in "Engineering News," Aug. 26, 1915, p. 386, was officially opened on May 7. This tunnel, 72 ft. wide, 40 ft. high and 4½ mi. long, is under the height of ground shoreward of Marseilles, France, and forms the southern end of the canal connecting that port with the River Rhone. It was thought that work on the tunnel had been suspended during the war, but evidently it has been kept up.

Mechanical Filtration and Disinfection of water from the Sacramento River have been recommended for Sacramento, Calif., by Prof. Charles Gilman Hyde, Berkeley, Calif., and George Wilhelm, Oakland. The estimated cost of a 30,000,000-gal. plant, which could be operated at a higher rate occasionally, is $1,288,000, most of which is for pumping and piping systems. Estimates for well and for mountain supplies are $1,315,000 and $10,000,000 respectively.

Sewage Disposal at New Haven, Conn., is to be studied by a commission of citizens acting with the five members of the aldermanic committee on sewers and sanitation. The citizen members are Henry B. Sargent, Albert B. Hill, Prof. C.-E. A. Winslow, Frank L. Homan and Howard F. Webb. Only preliminary investigations can be made this year, as no appropriation for the work of the commission has been provided. F. L. Ford is City Engineer of New Haven.

Prizes for Road Maintenance in Cuyahoga County, Ohio, are offered by the Efficiency League of Cuyahoga County, an organization made up of public officials of the various towns and cities in the county and of private citizens. Through the efforts of the County Highway Superintendent, W. A. Stinchcomb, arrangements have been made to award prizes to the town or city officials who do most efficient work in the maintenance of highways during 1916. Clayton W. Tyler, of Cleveland, is president of the Efficiency League.

New York Connecting Railroad Increases Bonds—A further bond issue of $8,000,000 is to be made by the New York Connecting Railroad. The total authorized issuing power of the company is $30,000,000, which sum is the estimated expenditure for its entire line through New York City. So far only $16,000,000 has been issued. This amount has been spent mainly on the viaduct portion of the line, from the Port Morris side of the East River via Randalls Island and Wards Island to Sunnyside Yard of the Long Island R.R. The new issue is to run 40 yr., at 4½%, and be redeemable at 105. The bonds must be sold at not less than 94.

The North Jersey Water-Supply Commission was appointed by Governor Fielder on May 5, in accordance with a legislative act. The object of the commission is to construct a dam and reservoir in the vicinity of Wanaque and a conduit therefrom to supply a number of cities and towns in northern New Jersey. The commissioners named are George F. Wright, Paterson; Ernest C. Hinck, Montclair; Dr. Wm. E. Ramsey, Perth Amboy; and Laurent J. Tonnele, of Bayonne. The last two are members, and Mr. Wright was once a member, of the State Water-Supply Commission, the functions of which on July 1 will go to the Department of Conservation and to new water-supply commissions for the northern and southern parts of the state. The North Jersey commissioners are to have cumulative probationary salaries of $1,500 a year each until a contract to supply a municipality has been signed, and $3,000 a year thereafter. It is expected that the North Jersey Commission will carry out the project reported on in 1911 by Morris Sherrard, Consulting Engineer, State Water-Supply Commission, Newark, N. J., in behalf of Newark, Paterson, Elizabeth, Montclair, East Orange, Totowa, Glen Ridge and Nutley.

Wages on Government Railroad Construction Work in Alaska have been adjusted by agreement between the Alaska Engineering Commission and the labor union at Anchorage. Work on the railway has been interfered with for several weeks by a strike for higher wages. The services of a Federal Board of Arbitration were brought in to settle the strike. The scale of wages agreed upon, according to an Associated Press dispatch, as follows:

Section labor, 40½c. an hour. Common labor, other than section men, 45c. an hour. Station laborers, track men and

experienced railroad construction workers, 46⅞c. an hour. Powder men, plumbers' helpers, machinists' helpers, blacksmiths' helpers, carpenters' helpers, 53⅛c. an hour. Longshoremen, 56¼c. an hour. Piledrivers and structural iron helpers, 60c. an hour. Steam engineers, ship caulkers, carpenters, blacksmiths and machinists, 70c. an hour. Plumbers, 75c. an hour. Steam-shovel engineers, $180 a month. Cranemen, $140 a month. Mule packers, $120 a month. Teamsters, $85 a month. Cooks, $90 to $120 a month. Operating department: Locomotive engineers, 70c. an hour. Conductors, 65c. an hour. Firemen, 46c. an hour. Brakemen, 44c. an hour.

Wire-Drag Resurvey Begins on Massachusetts Coast—The United States Coast and Geodetic Survey is about to make a resurvey by wire drag of Massachusetts Bay between Nahant and Cape Ann and of the western part of Cape Cod Bay between Plymouth and Cape Cod Canal. In Salem and Gloucester Harbors, the wire drags will be set at 33 ft. (mean low water). Elsewhere the maximum depth selected is 50 ft. at mean low water or 58 ft. at high water. The work will interfere temporarily with the operations of the fishermen, especially lobstermen, and it is essential that fishing operations be temporarily suspended in the particular localities where the work is in progress. In order to cause the least interference with the progress of the work and the operations of the fishermen, the area to be dragged is divided into sections about 5 sq.mi. in area. Charts showing the outlines of these sections, the order in which they will be dragged and a complete description of the method of buoying the section, are posted in post offices and other public places. Notices are attached to these charts from time to time to indicate the progress. Two parties will be engaged in this work, which will be carried on from May 15 to Oct. 15. They will have headquarters at Salem and Plymouth.

An Investigation of Canadian Railways is proposed by the Dominion Government, which has asked Parliament to pass an appropriation of $150,000 to defray the expenses of a commission to be appointed to investigate the condition of the Government-aided railways. The immediate cause for the creation of this commission is the inability of two of the Government-aided enterprises, the Canadian Northern and Grand Trunk Pacific, to meet the interest charges on the lines that have been built. Under present financial conditions these companies have not the money available to meet their interest charges and are unable to obtain new capital. To avoid throwing these great enterprises into bankruptcy the Government brought in a bill on May 2, providing for a loan of $23,000,000 by the Government to these companies. Of this amount, $15,000,000 is to go to the Canadian Northern to meet the interest charges on bonds, purchases of new rolling stock and new construction. The Grand Trunk Pacific will receive $8,000,000 to meet its interest charges, with a possible deficit in operating expenses and purchase of additional rolling stock. Both loans are to bear 6% interest, are repayable on demand and are to be secured by mortgage. The Government would have supervision of the expenditure of these loans. It is possible that the appointment of the new commission is a preliminary step to the taking over of one or both of these railway systems by the Government.

PERSONALS

Mr. John R. Sexton will succeed Mr. Carl W. Bucholtz as Division Engineer of the Meadville division of the Erie R.R.

Mr. Anthony Deahl, Attorney, of Goshen, Ind., has been appointed a Member of the Indiana Public Service Commission, by Governor Ralston, to succeed Charles J. Murphy, who recently resigned.

Mr. R. K. Brown, Division Engineer of the Salt Lake division of the San Pedro, Los Angeles & Salt Lake R.R., has been made Maintenance-of-Way Engineer of that railroad, with headquarters at Los Angeles, Calif.

Mr. Fred W. Waterman, M. Am. Soc. M. E., Chief Engineer and Acting Manager of the Lorain, Ohio, plant of the National Tube Co., will hereafter be Manager of the company's new tube plant to be constructed at Gary, Ind.

Mr. Halford Erickson, Chairman of the Railroad Commission of Wisconsin, has resigned to become associated with William Hagenah as practicing public-utility expert. His headquarters will be in the First National Bank Building, Chicago, Ill. Mr. Erickson has served on the Railroad Commission since its creation in 1905.

Mr. E. F. Mitchell, formerly Engineer of Construction and Chief Engineer of the Missouri Pacific System and for several years past engaged in the practice of consulting engineering, has been appointed Group Engineer of the Western Group of the Presidents' Conference Committee on Federal Valuation of Railroads. His headquarters will be at Chicago, Ill.

Mr. Eli B. Heisler, formerly Assistant Engineer on the Girard Estate mining operations in Schuylkill and Columbia Counties, Pennsylvania, has been appointed Second Assistant City Engineer of Pottsville, Penn. Mr. Heisler is a graduate of Pennsylvania State College. For a short time he was engaged as Junior Engineer in the United States Reclamation Service in Montana.

Messrs. George W. Tillson, M. Am. Soc. C. E., Henry G. Shirley, M. Am. Soc. C. E., and Arthur H. Blanchard, M. Am. Soc. C. E., a Commission of Engineers appointed by the Wilmington (Del.) Chamber of Commerce, have recently submitted a report on the administration, construction and maintenance of highways that are under the jurisdiction of the Levy Court of New Castle, Delaware.

Mr. Edmund M. Blake, who has been for some years Engineer in Charge of the Neponset River Improvement for the Massachusetts Department of Health, has accepted the position of Engineer to the Holbrook, Cabot & Rollins Corporation in the construction of the new dry-dock at Boston, Mass., which that company is building for the Directors of the Port of Boston. Mr. Blake was formerly Engineer on the Arrowrock Dam, at Boise, Idaho.

Mr. Walter Rowland, M. Am. Soc. C. E., has resigned as Assistant Engineer in Charge of Design of Docks and Piers, at Balboa, the Pacific terminal of the Panama Canal, comprising 2,490 lin.ft. of reinforced-concrete docks, 2,970 lin.ft. of steel docks and a 1,000-ft. reinforced-concrete pier, valued at $3,400,000. He is considering an offer from the Chile Exploration Co. to accompany Mr. S. B. Williamson, M. Am. Soc. C. E., in the development of west coast mineral properties at Chuquicamata and Braden.

Mr. Albert W. Walker, Assoc. M. Am. Soc. C. E., has been appointed Engineer in Charge of Investigations, Plans and Estimates of the newly formed Grand Valley Drainage District, with headquarters at Grand Junction, Colo. This district comprises about 50,000 acres of waterlogged land in the Grand Valley. Mr. Walker is a graduate of the Massachusetts Institute of Technology. He has been engaged with the United States Reclamation Service since 1905, for the past three years in charge of drainage on the Huntley irrigation project in Montana.

Messrs. David M. Duller and W. V. Burnell, of Houston, Tex., have organized the firm of Duller & Burnell, to conduct a general enginering business, with offices in the First National Bank Building, Houston. Mr. Duller has had a wide engineering experience and is especially qualified in the installation of power plants, chimneys and machiery, as well as garbage-disposal plants. Mr. Burnell until recently was County Engineer of Harris County, Texas, previous to which connection he served as Engineer and Superintendent of Construction for Stone & Webster. He has had considerable experience in electric-railway construction, water-works, street paving and various types of concrete construction.

OBITUARY

Prof. John Sweet, the oldest living past-President of the American Society of Mechanical Engineers, died at his home in Syracuse, N. Y., on May 8, at the age of 84.

William T. Wheeler, Secretary-Treasurer of the Port Jefferson (N. Y.) Electric Light Co., committed suicide on May 3 at the company's plant. It is understood that business troubles were the cause. Mr. Wheeler was 64 years old and lived in Port Jefferson.

Col. Albert E. Boone, a widely known railway builder and promoter of industrial and commercial enterprises, died at his home in Zanesville, Ohio, on May 3, at 71 years of age. He built the Ohio & Little Kanawa R.R. (originally the Zanesville & Ohio River Ry.) from Zanesville to Marietta, and the Zanesville Belt Line and Terminal Ry., connecting brick plants and outlying factories with the trunk-line railways entering Zanesville. He had lived in Zanesville for 35 years.

Lucien I. Blake, a well-known electrical engineer, died at the Boothby Hospital in Boston, Mass., on May 4. Professor Blake was born in Mansfield, Mass., in 1854 and graduated from Amherst College in 1878, after which he took the degree of doctor of philosophy, in Berlin. He was the inventor of a submarine signal and of an electrostatic ore separator. In making his experiments on the submarine signal he used the United States frigate "Constitution." Professor Blake was a brother of Percy M. Blake, Consulting Engineer, of Boston.

Frederick C. Kunz, Consulting and Bridge Engineer, Philadelphia, Penn., died on Wednesday evening, May 3, 1915, after a long period of ill health. Mr. Kunz was born in Austria 52 years ago and after completing his technical studies at the polytechnical school in Prague in 1886 he was for several years on the engineering staff of the Austrian Kaiser Ferdinand Nordbahn. Coming to the United States in 1891 he found employment with the Pencoyd Bridge Works in Philadelphia. The most important work on which he was engaged during his nine years' connection with the Pencoyd Bridge Works was the working up of the erection of the Niagara and Clifton arch bridges, both over the Niagara River. When in 1900 the company was absorbed by the American Bridge Co. he became Assistant to the Vice-President in charge of Enginering of that company, C. C. Schneider; he remained in this office until the summer of 1903. Mr. Kunz was appointed by Gustav Lindenthal, at that time Commissioner of Bridges of New York City, as Consulting Engineer of the Bridge Department, where he took an active and important part in the work of preparing specifications and plans for the Manhattan Bridge and the Queensboro Bridge. Early in 1904 he resigned to become the Chief Engineer of the Bridge Department of the Pennsylvania Steel Co. in Steelton, Penn., with whom he remained for several years. The most prominent work of which he had charge during this period was the construction of the Queensboro Bridge, on the safety of which he wrote a comprehensive report in 1908. Thereafter he established himself as consulting engineer, devoting a large part of his time to the writing of his work on "Design of Steel Bridges," one of the most comprehensive treatises on the subject in any language. Among his last construction work was the steel arch bridge at St. Johns, N. B., the plans for which were worked out jointly by the late C. C. Schneider and Mr. Kunz, who followed his friend to death within four months. Mr. Kunz' health had been poor for several years, and while his death came rather suddenly it was not altogether unexpected by his many friends, who sincerely mourn his demise.—O. H. Ammann.

Henry Floy, a consulting electrical and mechanical engineer, died suddenly at his home in New York City on May 5. Mr. Floy was born 50 years ago, at Elizabeth, N. J. He graduated from Wesleyan University in 1889 and then took a post-graduate course at Cornell University where he received the degree of M. E. in 1891 and the degree of A. M. in 1892. His first work was with the Westinghouse Electric Co. at Pittsburgh. After four years' service there he was transferred to the Chicago office as engineer and salesman, and a year later was put in charge of the office in Minneapolis. In 1898 he began practice as a consulting engineer in New York City in partnership with Prof. R. C. Carpenter of Cornell University. The partnership was dissolved three years later after which Mr. Floy practiced alone. His work was largely in connection with public utilities in the lighting and railway field. For several years he specialized in valuation work. In 1909 as the representative of B. J. Arnold, he had charge of the Bureau of Appraisal of the Public Service Commission of New York City, which was at that time engaged in appraising the properties of the street railways in greater New York and the elevated lines in Brooklyn. Mr. Floy was retained by municipalities as well as utility companies. In 1906 he made a report to the City of East Orange, N. J., on a proposed municipal electric-light plant; in 1907 he acted as arbitrator for the City of Colorado Springs on rates for public lighting. Mr. Floy was a Fellow of the American Institute of Electrical Engineers, and had served on its committees on Public Policy and on Appraisals and Valuation. He was also a Member of the American Institute of Consulting Engineers, the American Society of Civil Engineers, the Illuminating Engineering Society, the Engineers' Club, the City Club, and the University Club. At the Louisiana Purchase Exposition he served on the International Jury of Awards and was Chairman of the Committee on large electrical machinery. Mr. Floy was a frequent contributor to the technical press and to the proceedings of the societies of which he was a member. He was the author of treatises on the valuation of public-utility property and on high-tension underground electric cables.

HENRY FLOY

ENGINEERING SOCIETIES

INTERNATIONAL RAILWAY FUEL ASSOCIATION.
May 15-18. Annual meeting at Hotel Sherman, Chicago. Secy., J. G. Crawford, 702 East 51st St., Chicago.

NATIONAL DISTRICT HEATING ASSOCIATION.
May 16-19. Eighth convention in New York City. Secy., D. L. Gasgill, Greenville, Ohio.

SOUTHWESTERN ELECTRICAL AND GAS ASSOCIATION.
May 17-20. Annual convention in Galveston, Tex. Secy., H. S. Cooper, Slaughter Building, Dallas, Tex.

NATIONAL ELECTRIC LIGHT ASSOCIATION.
May 22-26. Convention in Chicago. Secy., T. C. Martin, 29 W. 39th St., New York City.

MASTER BOILER MAKERS' ASSOCIATION.
May 23-26. Annual meeting in Cleveland. Secy., H. D. Vought, 95 Liberty St., New York City.

AMERICAN IRON AND STEEL INSTITUTE.
May 26-27. General meeting in New York City. Secy., J. T. McCleary, 61 Broadway, New York City.

NATIONAL CONFERENCE ON CITY PLANNING.
June 5-7. Conference in Cleveland. Secy., Flavel Shurtleff, 19 Congress St., Boston, Mass.

AMERICAN WATER-WORKS ASSOCIATION.
June 5-9. Convention in New York City. Secy., J. M. Diven, 47 State St., Troy, N. Y.

MASTER CAR BUILDERS' ASSOCIATION.
Annual meeting, Atlantic City, N. J., June 14-16, 1916. Secy., Jos. W. Taylor, Karpen Bldg., Chicago.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
June 14-17. Eighth semiannual meeting. Cleveland. Secy., I. C. Olsen, Cooper Union, New York City.

SOCIETY OF RAILWAY CLUB SECRETARIES.
June 16-17. Annual meeting in Atlantic City. Secy., H. D. Vought, 95 Liberty St., New York City.

AMERICAN RAILWAY MASTER MECHANICS ASSOCIATION.
Annual meeting, Atlantic City, N. J., June 19-21, 1916. Secy., Jos. W. Taylor, Karpen Bldg., Chicago.

TRI-STATE WATER AND LIGHT ASSOCIATION OF THE CAROLINAS AND GEORGIA.
June 21-23. Annual convention at Isle of Pines, S. C. Secy., W. F. Stieglitz, Columbia, S. C.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
June 27-30. Annual meeting in Pittsburgh. Secy., Charles Warren Hunt, 220 West 57th St., New York City.

AMERICAN SOCIETY FOR TESTING MATERIALS.
June 27-30. Annual meeting in Atlantic City. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia, Penn.

The Intermountain Good Roads Association will hold its annual meeting June 13 to 14 in Ogden, Utah. The secretary is T. H. Burton, Nephi, Utah.

The Engineering Society of Buffalo held its final meeting of the season on the night of May 3 at the Hotel Statler. About 200 members were present. The membership of the society has grown to 450 and it is claimed that the average attendance at the meetings during the winter was 200. At the last meeting the existing officers were reëlected and include President John Younger; vice-presidents, W. A. James and Jesse G. Melendy; treasurer, William Dollar; and secretary, W. J. Gamble, 247 Rano St., Buffalo, N. Y.

The Detroit Engineering Society held its 22nd annual banquet on Saturday, Apr. 15, at the Hotel Statler, about 460 members being present. The speakers were Mayor Oscar C. Marx, whose subject was "The Relationship of Engineers To the City," Edgar A. Guest, of the Detroit Free Press, and Henry A. Wise Wood, of New York. At a business meeting held just prior to the banquet, the following officers were elected: President, Horace H. Lane; vice-presidents, William Pitt Putnam and L. R. Hoffman; secretary, D. V. Williamson, 46 Grand River Avenue W., Detroit, Mich.

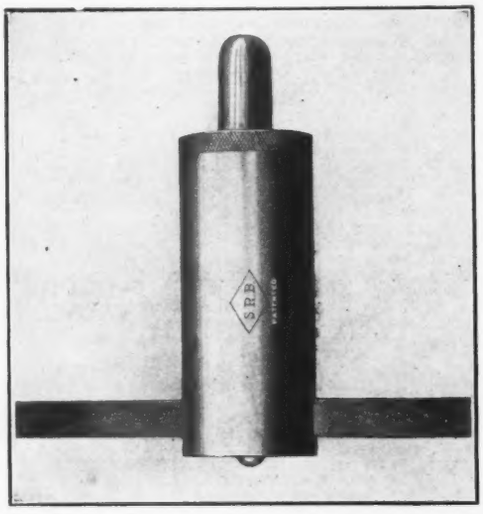
The American Water-Works Association holds its 36th annual convention in New York City, June 5 to 9. June 8 will be known as "Superintendents' Day," and will be devoted to answering questions proposed in advance, asking questions, exchange of experiences and short papers or talks on practical questions of interest to water-works superintendents. One of the questions to be discussed at this session is that of private fire services, their limits and the responsibility they entail upon the water-works company. Other interesting items will be experiences with fish in mains and methods of removing them, experiences with frogs in reservoirs, with pipe-locating and leak-finding devices, with purchase of supplies and materials for competitive bids, with strength of lead pipe, with electrolysis, and with cleaning sand, gravel or mud from mains. The secretary is J. M. Diven, 47 State St., Troy, N. Y.

Appliances and Materials

Portable Brinell-Test Outfit

A portable outfit for making the Brinell hardness test on metals, which weighs only 6½ lb. and goes into a 9¼x6¼x4-in. carrying case, is being sold by H. A. Holz, 50 Church St., New York City. It is not necessary to cut a specimen from the piece whose hardness it is desired to measure, and it is possible to test thinner sheets than practicable in the regular Brinell machine.

The portable tester is very simple, as may be seen from the accompanying illustration. There is a hollow cylindrical body having a longitudinal hole for a free plunger and a



PORTABLE BRINELL HARDNESS-TEST DEVICE

transverse hole for a standard square comparison bar. The plunger rests on the test bar and a 10-mm. steel ball is held loosely in contact underneath. With the apparatus assembled as shown, the ball is placed on the spot to be tested and the plunger is hit with a 3-lb. hammer. The depressions in the standard and unknown piece are calipered by transparent diverging-line gages. The hardness of the unknown piece is related to that of the standard by the inverse ratio of the squares of their widths of depressions.

The outfit complete comprises, besides the socket and plunger, a dozen 10-mm. standard balls, six standard comparison bars, two caliper scales, a set of direct-reading tables and a key for inserting new balls.

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Automatic Penetrometer

An automatic electrically controlled penetrometer for testing asphalts, etc., has been developed by Howard & Morse, laboratory-instrument makers, 1197 De Kalb Ave., Brooklyn, N. Y. It is claimed that this instrument eliminates personal equation from the penetration determinations. The device comprises a stand, with rising table for the specimen, and an upright supporting the loaded needle, penetration scale and timing clock. The clock is set to stop the needle in 1, 5 or 60 sec. In making a test the current is first turned on to hold the needle; then the asphalt sample is adjusted to the needle, using the rising table and a mirror. The clock is next set for the interval desired and the recording rack and dial set on the needle bar. The circuit is opened by pulling a chain, and the clock closes the circuit at the desired time, stopping the needle.

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Galvanized Metal-Flume Fittings

The R. Hardesty Co., Denver, Colo., manufacturer of the Hess, McGinnis and Lennon types of metal flumes, is now placing on the market flumes with galvanized-iron fittings throughout—rods, bars and accessories.

It has been customary since patent jointed metal flumes came into use a dozen or more years ago to use, at the joints, bars and rods that have been dipped in black paint or hot asphalt. This practice has continued in spite of the fact that specifications covering the galvanizing and protecting of the flume plates from corrosion have been growing more rigid. It has been found by experience that former methods of protecting the rods and ribs forming the joints are insufficient and are often responsible for the corrosion of the sheets. It is claimed that the zinc coating on the sheet surrounding the unprotected iron rod is thrown into solution by electrolytic action and is deposited on the rod or bar, leaving the flume sheet unprotected and subject to corrosion. The use of these galvanized fittings adds about 10% to the cost of the flume (exclusive of substructure).

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Small Mixer Equipped with Silo Hoist

The small concrete mixers ("Rex 6") of the Chain Belt Co., Milwaukee, Wis., are now furnished with a hoist for elevating buckets of concrete. This arrangement was developed especially for silo building. The hoist is located on the main countershaft of the mixer. It will operate with 100 ft. of ⅝-in. manila rope, 155 ft. of ½-in. rope, 280 ft. of ⅜-in., 400 ft. of $\frac{5}{16}$-in. and 650 ft. of ¼-in. wire cable. The average hoisting speed is 350 ft. per min. (single line). The hoist will lift 100 lb. with a 3-hp. engine when the mixer is loaded and 300 lb. empty. The "Rex 6" has capacity for 6 cu.ft. of loose material or 4 ft. of mixed concrete per batch and costs $300. The price includes loading platform, but the power loader and water tank cost extra.

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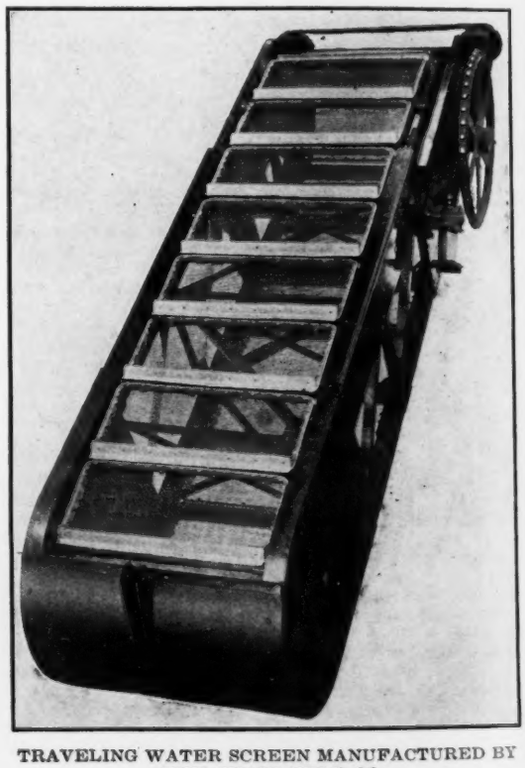
Traveling Intake Screens

Traveling screens for cleaning circulating and boiler water in power plants have been successfully employed for several years. The use of such screens, however, is outgrowing the central-station field. The Chain Belt Co., of Milwaukee, Wis., now builds them in standardized designs for any service requiring water free from the larger foreign particles.

The machines consist essentially of wire screening baskets mounted on two parallel steel-chain belts driven by a 3-hp. motor. The apron thus formed passes over sprockets at the top and bottom of the device, the sprockets being mounted on



TRAVELING WATER SCREEN MANUFACTURED BY THE CHAIN BELT CO

a supporting frame. Ordinarily the screens are placed on an incline, but they can be built to operate in vertical position, as was the case in the Commerce St. plant of the Milwaukee Electric Railway and Light Co. The particles screened from the water are carried upward on lips formed on the baskets. After turning over the head sprockets the particles fall into a trough, from which they are flushed out. The cleaning of the screen baskets after they pass over the head sprockets is accomplished by spraying from the back side.